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VETERINARY JOURNAL

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IMPORTANCE OF THE POULTRY INDUSTRY TO THE VETERINARY PROFESSION.

THE Poultry Industry, instead of being a side line to general agricultural farming, is now a firmly established branch of the live stock industry and, so far as can be gathered from those in a position to judge, a branch possibly more remunerative than any other at the present time.

An increase in the raising of any breed of live stock means an increase in the incidence of disease, and so is it with poultry. The attention given to poultry research in the past has been meagre, and it is generally felt that till very recently diseases of poultry have been little understood. It is true that, in America especially, greater attention has been paid to their study than in other countries, with the result that those engaged in poultry disease research have some indications of the problems they have to face. It is encouraging to be able to present a number of the VETERINARY JOURNAL devoted almost entirely to articles on poultry, as it serves to indicate the type and amount of work being carried out in this and other countries at the present time.

The importance of disease in the poultry world is being fully appreciated. In this country there are workers in several laboratories whose whole time is occupied in researches into poultry diseases. Attention is also being paid to the breeding of fowls with a view, as in the case of other animals, to obtaining the best yield of marketable produce. It is not so long ago since little interest was displayed in the egg production of a single hen or a group of birds. They laid *some* eggs, and that was all that was required. Now, by selective breeding, etc., it is not uncommon to read of hens with individual records of over 300 eggs per year.

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Naturally, disease questions interest us most. A perusal of the papers presented at the Fourth World's Poultry Congress, held in London in July of this year, will indicate the immense amount of research work in progress, and the variety of diseases being studied. A pamphlet of 191 pages was compiled of papers written by those who have studied the various disease problems. Diseases such as Bacillary White Diarrhœa, Coccidiosis, Fowl Pox, Avian Tuberculosis, Fowl Typhoid, Fowl Cholera, Parasitic Infestations, etc., formed the subject of these papers for discussion, and at the Eleventh International Veterinary Congress, held a month later, a similar group of subjects was dealt with. It is true that progress has been made, but a vast field of research is still open for the worker on poultry diseases.

The position of the veterinarian with regard to poultry diseases deserves a word of comment. In the past, the veterinary practitioner took but little interest in poultry, and with many it would appear that this still holds good. The treatment of individual birds, except they be of special value, cannot be a profitable undertaking, but in the various epidemics to which poultry are particularly susceptible, the veterinarian can be usefully employed. There is a tendency to-day on the part of the poultry farmer to ignore the veterinary practitioner; this is not surprising because of the lack of interest shown by the profession as a whole. It may be that this has been due in some measure to a general lack of knowledge on the subject of poultry diseases, but this state of affairs no longer exists, and it behoves the veterinary practitioner to keep abreast of the times by acquiring all the available knowledge on the subject, and by being able to impart this knowledge when required.

Poultry diseases are being studied, information as to cause, prevention and treatment is gradually being accumulated, and who, if not the veterinary surgeon, should be in a postition to make use of this knowledge to the benefit of the poultry farmer? Unless the veterinary profession displays a keener interest in the questions concerning the health of his stock, the poultry farmer will be forced to seek information elsewhere. In these days, when the profession is struggling for its proper position in the life of live stock in the country, it cannot afford to lose any opportunity to be of service; diseases of poultry offer such opportunity.

SOME POULTRY STATISTICS.

Readers of the Veterinary Journal will be interested in some of the statements made by P. A. Francis, Esq., O.B.E., Poultry Commissioner, Ministry of Agriculture and Fisheries, in an address given to a Poultry Conference a few days ago. It is very evident

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from his remarks that the poultry industry in this country is being taken up seriously, and that progress is being made rapidly.

His address included the following :—

Statistics for 1929 show that in the country as a whole fowls increased by 20 per cent.

Since 1913, the egg production in this country has increased over 100 per cent., which represents an addition to the national income of over £7,000,000.

The latest available figures show that the approximate annual value of home produced eggs and poultry is some £24,000,000, a sum equal to the value of the grain crop, including wheat, oats, barley, etc., and considerably greater than the value of the potato, fruit, and vegetable crops.

If the imports from abroad are taken into account, the total value of poultry, etc., consumed in this country is over £45,000,000. The average consumption of eggs in this country is less than that of several other countries.

The average consumption of eggs appears to be increasing, for in 1913, it was estimated at 115 eggs per head of the population, of which 80 were imported ; whilst in 1928, the estimated number was 132 eggs per head, of which 75 were imported.

Whilst our home production of eggs has practically doubled since 1913, foreign imports have not materially increased during that period ; in fact the import of eggs in shell in 1928 was less than in 1913.

The estimated average difference of prices between English and Dutch eggs in 1913 was 1½*d*. per dozen. By 1928, this difference had increased to 3*d*. per dozen, and in 1929 to 4.3*d*. per dozen.

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General Articles

POULTRY EDUCATION AND RESEARCH IN ENGLAND AND WALES.*

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THE development of poultry education and research in any real sense of the words is a creation of the eleven years since the War. Before 1914 a few countries possessed poultry instructors or provided occasional lectures on poultry-keeping ; and one or two agricultural colleges gave a little instruction, as part of their general course or by special courses in the summer. But substantially it is true to say that what was done was quite inadequate to the possibilities of the industry, of which, then as now, Sir Edward Brown was the apostle. Since the War, however, there has been a complete change ; the importance of the industry has been recognised by the general public, by the Government, and by men of science, with the result that a system of education and research has been established which, though perhaps still incomplete, is nevertheless considerable both in its magnitude and in the benefits which it has conferred and is conferring upon the industry.

The organisation of that system is based upon two principles. First, it is desirable that education in poultry husbandry should not be separated from education in other forms of agricultural production, but should be associated with it as closely as possible. There are several reasons for this view, but only two need be mentioned here. In this country a very large proportion (probably not less than half) of the egg and poultry production comes not from holdings devoted solely to poultry, but from farms and holdings where poultry is only one among several agricultural products, and of which the occupants are engaged in what may be called general farming as distinct from specialist poultry and egg production ; again, though poultry-keeping has of course its own problems, nevertheless from one point of view it is a branch of the great livestock industry, and those engaged in it cannot but derive benefit from some acquaintance with the principles and methods on which other livestock are bred and managed. Secondly, in poultry research the English system is similarly organised upon the principle that it should be associated as closely as possible with research in other branches of agriculture. In breeding, in nutrition, in the prevention and treatment of disease (to take three main divisions

* A paper presented to the Fourth World's Poultry Congress, 1930.

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of work on poultry), research must lose if the workers are dissociated from the men engaged on the fundamental problems common to all livestock, and on the application to other livestock of the results reached by those fundamental researches.

The application of the first principle has led to the organisation of poultry education on the following lines. In England and Wales there are 14 agricultural colleges or university departments of agriculture (including two colleges for women only), largely supported by Government grants ; these institutions provide a two or three years' course in agriculture leading up to a degree or diploma. At all of these instruction in poultry-keeping is an integral part of the course ; practically all have a model plant and a flock of birds which, I am glad to say, is usually a source of not inconsiderable profit to the institution. In addition, some of the colleges run special short courses in poultry-keeping for those who have not the time or money to take the full course.

Instruction of a more elementary and immediately practical nature falls to the county councils. Seventeen farm institutes are conducted by these authorities in England and Wales ; a farm institute is an institution, nearly always residential, providing usually a principal course of six or nine months in general agriculture for the children of local farmers, and in summer a short course in dairying and poultry-keeping. But though these are the usual courses, there are numerous variations ; in particular, at many of the farm institutes extended provision is made for instruction in poultry-keeping by courses ranging from 33 weeks down to 9 weeks, as well as special intensive courses of a week or two. It may be mentioned that the fees of farm institutes average around about 30*s.* a week for tuition, board and lodging, and that numerous scholarships are given by the Ministry of Agriculture and the county councils to enable promising students to take courses. Finally, apart from the 17 farm institutes, the county councils also provide itinerant instruction and advice on a large scale. Nearly every county council now has on its staff a poultry instructor or instructress, and several have more than one. Last year county councils employed 53 poultry instructors or instructresses, and 16 who taught and advised in poultry-keeping and dairying combined. Although there are no definite figures available, these county council officers must have given hundreds of lectures, conducted dozens of classes, and advised hundreds or thousands of poultry-keepers upon their methods.

I have left to the last what is from one point of view the crown of the system of poultry education—namely, the advanced training which is provided by the National Institute of Poultry Husbandry at the Harper Adams Agricultural College. This institution provides not only an elementary certificate course in poultry husbandry extending over

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one year, but also an advanced certificate course requiring a further year, and a research course open to holders of advanced certificates. The advanced certificate course is especially strong in training in the fundamental sciences and related subjects ; the research course, as its name implies, directs the student to advanced experimental work in scientific problems arising in the field of poultry husbandry. The Institute of course prepares students for the National Poultry Diploma, which is a qualification given by a special National Examination Board after a rigorous examination both in theory and in practical subjects. It is to this Institute that we in this country look for the provision of teachers and research workers of the first grade, as well as of men and women who will themselves apply the latest knowledge in commercial egg and poultry production.

I will now turn to research. On the principle stated in the second paragraph of this paper, poultry research in this country is conducted not at one institution devoted to such research and nothing else, but at several. Breeding research is at Cambridge in the charge of Professor Punnett, the University Professor of Genetics ; the nutrition work is in the direct charge of Mr. Halnan, who works as part of the great Cambridge School of Agriculture, until recently controlled by the ever-lamented Professor Wood, and now by his successor, Professor Engledow ; research into poultry diseases is entrusted to the Ministry's Veterinary Research Laboratory at Weybridge, in Surrey, where it is specially in the charge of Mr. Doyle, under the general superintendence of the Director, Dr. Andrews. Two additions have been made to the scheme at the instance of the industry itself. At Reaseheath, in Cheshire, there is a station for carrying on practical experiments in breeding for egg production, and at Wye, in Kent, a station for practical experiments in the breeding of poultry for the table. Both are closely associated with educational institutions: the former with the Cheshire School of Agriculture, and the latter with the South Eastern Agricultural College. These stations do not occupy themselves with fundamental research, but with more immediately practical questions on which guidance is wanted ; they are, however, conducted under scientific guidance and with the closest attention to the scientific questions involved.

Finally, it is one most important function of the Institute of Poultry Husbandry at the Harper Adams College of Agriculture to act as a link between the research worker and the men engaged in the industry. It is the business of that Institute to carry on such activities as practical and commercial experiments, and demonstrations for the testing of new systems of poultry-keeping, foods and appliances. This most important work was deliberately located at the Harper Adams College, because it provides most useful material for teaching purposes, and provides also the practical work, with which men engaged in teaching poultry students should always be in close touch.

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HELMINTH PARASITES OF POULTRY.

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THE internal parasites are of considerable importance to those interested in the raising of poultry, especially to those who are compelled to keep the birds in a comparatively limited space. All the various groups of helminths are represented in domestic birds, and most of the systems of the body are infected. It is not the purpose of this article to consider species which are still of purely academic interest; the fact that about a hundred are already known from the ordinary domestic fowl alone, renders this impossible. Accordingly, only the more important forms will be discussed according to habitat, and from the point of view of prevention.

A number of related forms also occurs in the eyes of birds, but they are less important. Very often the presence of the parasites causes little or no inconvenience; at times, however, they appear to cause considerable irritation. Secondarily, the eye may become infected with micro-organisms, and loss of sight, followed often by death, results. Treatment is symptomatic, following the mechanical removal of the worms. Dilute creolin (1% to 2%) has been recommended for killing the parasites. Prophylaxis depends on the eradication of the intermediate host.

The Eye Worm.

Although not present in Britain, *Oxyspirura mansoni* is an important parasite of the nictitating membrane of poultry and other domestic birds in various parts of the world. It is a small round worm, under two cm. in length. The female produces minute eggs, which are washed down the tear duct and swallowed. In this way they reach the exterior in the droppings. There they are swallowed by cockroaches. The eggs hatch in the insect and the larvæ penetrate the alimentary canal and encyst, remaining in this condition until the cockroach is swallowed by a bird. They then escape, probably in the crop, and make their way to the eye where they reach maturity.

The Gape Worm.

This is one of the most spectacular parasites of birds, and is one which is probably most familiar to poultry breeders. *Syngamus trachea* differs from most other nematodes in having the sexes permanently joined *in copula*. The female is a bright red colour, and

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is a few centimetres in length, the size varying to a considerable extent with the host. The male is very much smaller, and is permanently joined to the female at the anterior end of her body to form a Y. The two heads of the Y are attached to the mucosa of the trachea or bronchi. The eggs are passed out into the air passages between the bursa of the male and the body of the female, and reach the exterior in the droppings after being coughed up from the air passages and swallowed. On the ground they develop in about a week, and they may or may not hatch shortly after. Birds become infected by swallowing the mature egg or the hatched larva which they pick up with the grit or in worms (the worm is not an intermediate host, merely a passive carrier of the egg). The larvæ quickly make their way to the lungs, where they pair and gradually work their way up to the larger air passages. They reach sexual maturity about a fortnight after reaching the trachea; and eggs may be found in the droppings as early as 17 days after infection. The whole life cycle may be completed in under a month.

The parasite appears to be a normal parasite of turkeys (and perhaps also of several species of wild birds), and causes few if any symptoms in them. The greatest damage is caused to the young of other birds, which are not normal hosts. Young chickens suffer severely from their attack, and the death-rate is high. Older birds, on the other hand, are either slightly affected or are immune to the bad effects of the nematode.

In recent years it has been shown that the parasite can be carried to poultry farms by various species of wild birds, and in this way epizootics may be started. Nevertheless, the infection is maintained mainly by domesticated birds, and turkeys are particularly dangerous in this respect.

As in most worm infections, prevention is much more important than cure. Where the disease, which is shown by the characteristic "gaping" and progressive emaciation, is known to exist, freshly-hatched chickens should be immediately placed on clean ground, and old runs ploughed and seeded for two or three years. Turkeys should not be kept on the same premises, and it may be desirable to take steps to prevent the contamination of the chicken by the droppings of starlings and other wild birds. Treatment consists in the removal of the worm from the trachea either mechanically or by the use of drugs.

The Trematodes.

There is probably only one trematode of economic importance in poultry, and it occurs in the oviducts. It may prove fatal, or

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may interfere with egg laying and cause a general emaciation. Not infrequently it is found in the egg, and, speaking from experience, it is rather a repulsive object to find in the breakfast egg.

The Tapeworms.

There are various species of tapeworm in the small intestine of poultry: some of these are only a few millimetres in length, and none are more than a few centimetres long. They are carried by a variety of invertebrates which serve as food for the birds: slugs and snails, earthworms, insects and crustaceans, and so on, although in many cases the life-cycles are still unknown. It is doubtful if they normally do much damage unless present in considerable numbers. One species, however, produces small nodules on the small intestine which superficially resemble those of tuberculosis. They do not, however, infect the liver, or cause any of the other classical symptoms of avian tuberculosis. If tapeworms are present in numbers, they may interfere with digestion, cause avitaminosis, emaciation, and so on.

The Intestinal Round-worm.

In the small intestine of poultry, and occasionally in other parts of the alimentary system, or even in the reproductive system, is found *Ascaridia galli*, the female of which is 6 to 12 cm. long, and the male 3 to 8 cm. long. Like the Ascarids of mammals, both sexes possess three lips, but the male is specially characterised by the possession of preanal sucker. The females lay a very large number of eggs which, after a period of incubation on the ground lasting for a fortnight or so in summer, become embryonated. Like Ascaris, the eggs do not normally hatch until they are swallowed, and apparently the young worms pursue such a wandering course through the blood stream as do the Ascarids.

The Cæcal Worm.

In the cæca of numerous species of domesticated birds is found a small white nematode called *Heterakis gallinæ*, between one and one and a-half cm. long. The œsophagus possesses a well-developed sucking bulb, and the male has a preanal sucker. The eggs pass to the exterior in the usual way, and become embryonated in a week or ten days in summer. The eggs do not hatch until they are swallowed, and apparently the development does not entail a larval migration to the lungs. They become mature in about four weeks.

There are other species of intestinal and cæcal worms present in birds, but, except in rare cases, they are of minor importance. Treatment is not entirely satisfactory, but good results are obtained

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by an infusion of tobacco, administered after 24 hours starvation, and followed by Epsom salts two hours later. One pound of chopped tobacco stems soaked in water for two hours, then mixed with half the usual ration of ground feed, suffices for 100 birds; while the Epsom salts can be administered at the rate of 11 oz. in a quarter ration of ground feed. The treatment should be repeated in ten days.

Prophylaxis demands routine cleanliness. To prevent re-infection, remove the birds after treatment to clean temporary quarters, and remove the loose soil, droppings, etc., from the old run for a depth of several inches. Alternatively, it may be allowed to lie fallow for a year. As with mammals, permanent quarters are the most serious source of infection, and will build up a serious infestation from a very small beginning.

General.

It is a mistake to think that parasites are important *only* when they cause death and obvious disease. Their greatest importance usually is the almost imperceptible drain on the strength of the bird, with a reduction in vitality, egg production, condition, and so on. They are a major accessory cause in many protozoal and bacterial diseases. Accordingly, prophylaxis is much more important than cure. General measures include strict attention to sanitation, provision of clean food and water, prompt and thorough removal of droppings, isolation of sick birds and, wherever possible, change of ground. Profitable poultry-keeping demands a continuous and vigorous fight against a filthy environment, and this is especially so in the case of the parasitic worms.

IODINE IN THE CONTROL AND TREATMENT OF AVIAN COCCIDIOSIS.

By W. R. KERR, M.R.C.V.S., D.V.S.M., and G. H. BOTHAM, B.Sc.

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THE great post-war expansion of the poultry industry brought in its train a concurrent increase in poultry disease, one of the most important of which is undoubtedly coccidiosis. This disease has become a serious menace to the industry during the last few years. A great amount of research work has been carried out, but there is need for further investigation and greater attempts at correlation of results, which, at the present time, are more or less divergent, but few points being unanimously agreed upon.

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Coccidiosis is primarily a disease of young chickens caused by the protozoan parasite *Eimeria* (*coccidium*) *avium*.

This paper contains data and results of experiments collected in the control and treatment of avian coccidiosis, including a section on the chemical phenomena. A preliminary report of this investigation has been previously published (W. R. K.)(1).

Historical.—It is many years since coccidia were stated to be the causal agents of disease in birds and animals. Hake, 1839 (2), described a protozoan which he named " psorospermium " as the cause of enteritis in rabbits. Many contributions were added, but not until 1881 was its importance realised in the bird family, when Rivolta and Delprato (12) described a parasite, *Coccidium pfeifferi*, in the pigeon. This was followed by the work of Eckhardt (13) in 1903, who showed that epidemics amongst poultry in Germany and other European countries were due to *Coccidium tenellum*. Since that period the parasite has been described in many birds, and in each case, a different name has been given, but, according to Hutyra and Marek (3), are probably only different varieties of *Eimeria avium*.

It is not intended in this paper to give the life-history of the coccidium, as this has been done by many workers, and reference need only be made to the valuable work of Schaudinn on the life-history of the coccidium in the centipede, followed by the contributions of Fantham (4), Jowett (5), and others.

Occurrence of the Disease.—Beaudette (6) states " observation shows that the disease most always appears with the coming of spring ; that the weather conditions of winter are not favourable to the development of the oöcyst, and doubts if many oöcysts survive such conditions."

Undoubtedly the disease has an apparent seasonal occurrence corresponding with the hatching season in the spring. The fact that outbreaks occur in the autumn when hatching for table purposes is undertaken, emphasises this statement. It is worthy of note that many cases have been diagnosed in this province during the months of September, October and November. The prevalence of the disease is evident on farms where all-year hatching is adopted, reaching its maximum in June and July, and its minimum in January. The cause of the minimum is probably due to the destruction of many of the oöcysts by the weather conditions as cited above. Two points of interest are noted with regard to the incidence of the disease, and these are : firstly, that warm wet weather is said to favour its occurrence. Nevertheless, many outbreaks are encountered

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in July, the driest month of the year, when the bulk of the hatching season is over, showing a remarkable increase in the ratio of outbreaks to the number of hatchings. The other point is that the virulence of an artificial outbreak amongst chickens in a hoover is not reduced even when there is a degree of dryness unlikely to be found under natural circumstances.

From these observations we agree with Johnston (7) that the coccidium shows a tendency to acclimatisation. Under unfavourable conditions many of the oöcysts are ruptured, but still some seem to resist and remain infectious.

The usual history of coccidiosis on many farms shows that a few deaths are experienced in an early hatch, but with subsequent hatchings these increase in number until a heavy mortality occurs, pointing to an accumulation of infectious oöcysts, yet the complication arises of outbreaks with a heavy mortality and no history of previous losses. In this connection the adult carrier assumes importance, and is the probable cause of the infection.

Undoubtedly the occurrence of the disease is in the ascendant, and in this area it is evident from the reports received that it has extended considerably in the last few years. The factors contributing to the present position are the increase in poultry husbandry, the artificial systems of rearing, and the traffic in poultry.

Control.—For the purpose of description, this is divided into : (*a*) Chemical disinfection ; (*b*) Sanitary measures.

(*a*) The position of chemical disinfection in this connection is unsatisfactory, for, despite the fact that Johnson (7) and others state that it is ineffective, its use is still largely recommended. With this point in view, experiments to determine the efficiency of such chemical disinfection were set up.

Method.—Fæces rich in oöcysts were collected from a large number of chicks and, having been washed and centrifuged, were placed in definite quantities of 1 c.c. in separate Petri dishes, and covered to a depth of 0.5 centimetre with the disinfectants to be tested. The dilutions were those advised, and in some a much greater strength was employed than used in practice, where it is usually carried out in an inefficient manner, mainly due to the lack of facilities and proper personal factor.

The oöcysts were examined microscopically before being placed in the dishes, and in no case was sporulation observed. Each dish was areated twice daily by means of a glass pipette, following the method adopted by Biester and Murray (8).

Evidence of sporulated oöcysts being regarded as positive.

TABLE I.

Disinfectant.	2 days.	3 days.	5 days.	12 days.	Remarks.
1 Carbolic acid 1%	+	+	+	+	Sporulation good
2 Chinosol 0.05%	+	+	+	—	,, fair
3 ,, 0.01%	+	+	+	+	,, good
4 Iodine 0.1%	+	+	+	+	,, ,,
5 Aniline dye 0.01%	+	—	—	—	,, poor
6 Potassium bichrom. 0.5%	+	+	+	+	,, good
7 Potassium bichrom. 50%	+	+	+	+	,, fair
8 Derris sol. 4%	N. C.	N. C.	N. C.	—	Negative
9 Jeyes fluid 5%	+	N. C.	disintegrated		Sporulation few
10 ,, ,, 2%	+	N. C.	disintegrated		,, ,,
11 ,, ,, 1%	+	+	N. C.	N. C.	,, ,,
12 Sodium chloride 2½%	+	N. C.	N. C.	N. C.	,, ,,
13 Mercuric perchloride 0.1%	+	+	+	+	Sporulation fair
14 Iodine suspensoid 0.8%	+	—	—	—	,, few
15 Control tap water	+	+	+	+	,, good

N. C. = centralising of nucleus. + = sporulation.

Carbolic acid, chinosol and potassium bichromate showed the maximum sporulation. Iodine suspensoid appeared to be the only chemical with a definite action on the oöcyst, causing staining of the protoplasm and rupture of the wall, yet certain of the oöcysts seemed to resist its action.

Having obtained these results it was decided to inoculate chicks in groups of three to determine if artificial infection could be produced in chicks from sporulated oöcysts treated in such a manner.

The emulsions were centrifuged and washed before inoculating the chicks by means of a medicine dropper. Three chicks from the same batch were retained as controls.

5th day : Iodine, Jeyes fluid 1 per cent., carbolic acid, and the control showed the presence of unsporulated oöcysts in one or other of the group.

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6th day: Chinosol 0.01 %, potassium bichromate 0.5%, and mercuric perchloride showed the presence of oöcysts.

None of the others revealed oöcysts, but a negative result in this event does not necessarily mean that destruction of the sporoblasts had taken place. The non-inoculated controls failed to show the presence of oöcysts at any of the examinations.

It is evident that disinfection by chemical means effects no control whatever ; indeed, in many cases it seems to assist sporulation by controlling the process of putrefaction. The percentage of sporulation is lowered, but not eliminated, by the presence of putrefactive material, and we agree with Johnson (7) that certain forms of coccidia are resistent to such changes.

(*b*) *Sanitary Measures.*—The phase in the life cycle where 48 hours are required for the sporulation of the oöcyst, and the fact that moisture is essential, forms the basis of control measures, since unsporulated oöcysts, if ingested, do not produce coccidiosis.

The statement that the severity of the disease depends to a certain extent upon the number of sporulated oöcysts present (Johnson (7)) holds good in most cases, but the occurrence of so-called spontaneous outbreaks accompanied by a high mortality, leads to the conclusion that other factors, including vitality and adult carriers, play an important part. That there can have been an accumulation of infective oöcysts under such circumstances is improbable. A case of an outbreak in a battery brooder amongst twenty one-day-old chicks accompanied by a 100 % mortality supports the theory that vitality is a factor, where this may be lowered by the probable faults in such a system. The rearing had been undertaken on wire floors, as in ordinary battery brooder practice, with no previous losses, so it can only be assumed that sporulated oöcysts, probably few in number, were introduced through the medium of the water, utensils, or egg-shells. (Emmel) (9).

The methods advocated in an attempt to break the life cycle of the parasite fall into three groups :—

(1) Removal of the droppings at least every second day by strict mechanical cleansing.

(2) Moving of floorless pens in the same period.

(3) The use of wire floors which allow the droppings to pass through.

These methods exert a controlling effect on the course of the disease, and though of certain value are limited in the extent of

their control. The last is more evident in rabbitries, where the use of wire floors does not always prove successful. The case of the battery brooder can also be cited as an example of its limitation.

The oöcyst has two enemies—heat and drought. Heating at 80° C. kills ; and exposure to the direct rays of the sun causes rupture of many of the oöcysts. Therefore the use of boiling water and sunshine is to be commended in the control of the disease.

Treatment.

The sanitary measures on the whole have been accepted as a standard in the prophylaxis, but the same cannot be said with regard to the use of drugs, for extreme variance of opinion, ranging from scepticism on one hand to confidence in a drug, or combination of drugs, on the other hand, now exists. Attempts were made to combine treatment with reasonable sanitary measures, the method adopted being to test the usual drugs or combination of drugs generally advised against controls of untreated birds. This was necessary in view of the contradictory reports as to their use and effectiveness.

Method.—Infection was procured by artificial means : an emulsion of the oöcysts, previously sporulated in potassium bichromate, 0.5%, and carbolic acid, 1%, being centrifuged, washed, and injected into the crop in 0.5 c.c. doses by means of a medicine dropper.

The first experiment was set up to determine the value of catechu (Fantham) (4), chinosol, dried skim milk (Fantham) (4) and Beach (10), against untreated controls, the treatment commencing on the presence of oöcysts in the fæces.

Treatment.	No. of chicks.	Age.	No. of deaths.	% recovery.
(1) Catechu in drinking water ...	6	14 days	6	—
(2) Chinosol, 0.3% of mash ...	6	,,	6	—
(3) Dried skim milk, 25% ...	6	,,	5	16.6
(4) Control	6	,,	4	33.3

In this experiment it was evident that the infection had been too severe, yet it illustrated the fact that the controls in such fared better than the others. The experiment was repeated, using half the original dose, but in this only one death occurred, being in Group I, although the chicks showed numerous oöcysts in the fæces.

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Several drugs were tried with unsatisfactory results against artificially produced infection, with the exception of milk products (Beach) (10), which, if not entirely effective, showed more promising results; they are referred to later. The production of artificial infection is difficult, for the virulence of the sporulated oöcysts is variable.

It is realised that drugs are limited in their action, and that results hitherto have been poor and inconclusive. Most of them are supplied to the affected birds through the drinking water; the possibility arises here of the combination of these drugs with the ingesta and mucus of the crop and gizzard, and they may therefore be rendered ineffective before reaching the intestine and cæca. Others have no direct action on the parasite, but depend on symptomatic treatment.

Digestion.—Zublin (3) states that "it requires six to eight hours for digestion of the oocyst by the pancreatic juices." With this in view, it was decided to determine if possible the effect of certain drugs on the digested oöcysts. Several digests, including ingluvin, papain, amylopsin and trypsin were used; trypsin was the only one found to digest the mucilage of the operculum. Incubated at 37° C., the time required for complete digestion varied from four to six hours.

Chicks in groups of four were inoculated with digested oöcysts which had been treated with several drugs, notably iodine 1–10,000, for a period of two minutes, then centrifuged and washed. Two control groups were used, one being inoculated with digested oöcysts.

The treated groups remained negative to microscopic examination of the fæces, as also did the non-inoculated control. At the seventh day, unsporulated oöcysts were observed in the fæces of the inoculated controls, this being regarded as evidence of completion of the life cycle. This pointed to the fact that endogenous forms are readily destroyed by certain chemicals, although the oöcyst remains impervious. However, to be effective, the chemical must be in a free state in the lower portion of the small intestine.

The possibility of iodine in this connection occurred to W.R.K. (1), and experiments were carried out to find the most convenient form in which it could be effectively administered. It was decided to utilise the power that milk is known to possess of taking up comparatively large quantities of iodine with relative ease.

A solution was made up as follows:—

Iodine resublimate	1 gramme
Potassium iodide	2 grammes
Water	50 cubic centimetres.

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This formed the stock solution, which was added to separated or whole milk in the quantities one to nine by volume. This mixture is heated at approximately 70° C. till it becomes white. One pint of this preparation is added to the gallon of drinking water, and given to the chicks *ad lib.*

Having produced a suitable form of iodine in combination likely to satisfy our requirements, experiments were set up to compare its effect with that of milk products. In this experiment, chickens 14 days old were used in groups of six, under the same conditions with regard to hoovers, temperature, and feeding.

Experiment 1.	No. of chicks.	Deaths.	Remarks.
(*a*) Control	6	1	numerous oöcysts
(*b*) Iodised milk	6	0	,, ,,
(*c*) Skim milk powder 40% of ration ...	6	0	not so numerous

This experiment failed to supply the necessary data.

Experiment 2.—Three hundred chicks from a batch of 340 (40 having died in the two previous days) were split up into two groups, no attempt being made to apply sanitary measures. A 66% mortality was experienced from the previous batch of 300.

	No.	Deaths				
		2nd day.	3rd day.	4th day.	5th day.	Total
(*a*) Dried skimmed milk ...	150	3	2	2	2	9
(*b*) Iodised milk	150	3	1	—	1	5

Experiment 3.—Two hundred chicks split into two groups, the losses in the two previous days being 18.

	No.	2nd	3rd	4th	5th	Total.
(*a*) Dried skim milk ...	100	3	2	—	1	6
(*b*) Iodised milk	100	1	1	—	—	2

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Experiment 4.—To determine the effect of feeding iodised milk prior to infection.

	No.	Deaths.	Remarks.
(*a*) 25% dried skim milk in mash	6	2	Oöcysts numerous
(*b*) Iodised casein in mash ...	6	1	,, ,,
(*c*) Iodised milk in water ...	6	0	,, few
(*d*) Control	6	3	Hæmorrhage in cases. Numerous oöcysts

This experiment unfortunately is not on a large enough scale to give an accurate percentage result without fear of coincidence or variation.

This preparation seemed to fulfil the desired conditions, and its use was extended to field work, to outbreaks under our observation where coccidiosis had been diagnosed by post-mortem and microscopic examination. A few examples of the results are included at this stage in the form of a table.

	No. of chicks.	Age.	Deaths 3 days previous to treatment.	Losses after treatment.	Remarks.
(1)	200	3 weeks	18	2	1st and 2nd day after
(2)	49	5 weeks	8	—	—
(3)	208	3 weeks	54	2	2nd day
(4)	100	8 weeks	20	—	—
(5)	300	5 weeks	30	7	condition fair
(6)	160	6 weeks	27	2	,, good

The difficulty in drawing conclusions from such results in the treatment of natural outbreaks of coccidiosis is appreciated. The

factors of the disease being self-limiting in its course, that mechanical cleansing was advised, and that the chicks were retained on the original floors, have to be considered.

The combination of sanitary measures, and the use of iodised milk was issued to the county poultry instructors in the West Midland Province: the results obtained have been highly satisfactory. Here again the point of not being able to run control sections in such outbreaks detracts from its value. Nevertheless, such results indicate that the natural extension of its application to this and to other conditions is to be adopted.

The feeding of iodine in this form, even in massive doses, is non-toxic over an extended period.

Adult Coccidiosis.—During the course of the investigation, and more especially in the autumn period, cases of this kind were brought to the notice of this department, some six outbreaks having been confirmed. The number of birds affected ranged from 200 to 1,500, and the ages four to six months. The results of the combination of measures seemed to have a beneficial effect in prevention and in the condition of the recently affected birds, but no change occurred in those affected with the post-coccidial symptoms of blindness, lameness and paralysis.

Rabbit Coccidiosis.—Inoculation of chicks with massive doses of sporulated oöcysts obtained from rabbit sources failed to produce a similar condition in chicks.

Microphotographs are appended illustrating the *Eimeria cuniculi* used for this experiment in comparison with *Eimeria avium.*

Chemical Aspect of the Investigation.

A certain amount of chemical work has been carried out in connection with this investigation, but the complexity of the problem compels us to consider only the general nature of our findings in this direction. The authors hope to publish all relevant chemical data in a further paper.

Before any idea of the mechanism of the action of the iodised milk preparation can be formed, it is obvious that some knowledge of its chemical nature is essential. The solids, not fat, of skim milk consist mainly of lactose, proteins and various salts. It was found that a 4% aqueous solution of lactose took up very little iodine under the conditions of our experiment with milk, so it is reasonable to assume, particularly as many complexes of iodine and protein are known, that the milk proteins are responsible for the large absorption found. The body (or mixture of bodies) formed may be of the following types: a mechanical mixture, colloidal iodine protected by the protein, an adsorption complex, definite chemical compounds of proteins and iodine.

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The hypothesis of mechanical mixture may be immediately rejected, as the iodine cannot be separated out mechanically, and the product does not exhibit any trace of the colour of the iodine solution.

The suggestion that the iodine is in the form of a protected colloid is interesting, since Chandler (14) (15) claims success in the treatment of coccidiosis by the use of a suspension of iodine stabilised by various protective agents. There is a popular belief that when iodine in potassium iodide solution is added to milk "colloidal" iodine is produced. We have been unable to trace the origin of this statement, but during our inquiries have elucidated the fact that Chitty (16) records four cases of actinomycosis cured by the administration of iodine in milk, where in one case at least "collosol" iodine had failed. Presumably, the "colloidal" iodine is protected by the proteins until these latter are hydrolysed in the intestines, the slowly liberated iodine then uniting with organic matter and bacterial membranes present. If the proteins of milk merely act as protective colloids, the recriprocals of Zsigmondy's gold numbers, which give a measure of the protective action of colloids indicate that gelatine should be able to protect much more iodine than does an equal weight of milk proteins. This we found by experiment is not the case. Further, digestion with trypsin did not liberate any iodine from the iodised milk; starch-iodide indicator was quite unchanged when added to the digest. It is difficult to believe that the amino acids produced by the above process are able to act as protective agents to anything approaching the same extent as the proteins, for in one case we are dealing with crystalloids, and in the other case with colloids.

Lieben and Lazlo (17) performed some experiments with iodine and the sodium salt of casein, and found that the amount of iodine varies with the amount of iodine used, much being adsorped. The well-known formula of Gibbs indicated that adsorption varies inversely as the temperature, so that by working at a lower temperature than that we used, more iodine should be taken up, if this is largely an adsorption effect. This was proved not to be the case, for the milk takes up much less iodine at room temperature than on the water bath. Also, as in the case of "colloidal" iodine, production of crystalloids from a colloid should reduce absorption effects, with production in our case of free iodine. As mentioned above, none was detected in digestion experiments with trypsin, pepsin, erypsin, ingluvin, papain and mixtures of these enzymes.

The possibility of iodine actually uniting with the protein is very great, for iodo compounds of casein were prepared as long ago

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as 1897 by Liebrecht (18). He describes the preparation of three products which contained about 6%, 9% and 18% of iodine respectively. Schryver (19) mentions several compounds of various proteins with iodine, and the Extra Pharmacopœia gives a list of protein-iodine complexes used in medicine. It is almost certain that one of the linkages in the protein molecule is the "peptide linkage,"

$$R — CO — NH — R,$$

and according to Zinster (20) considerable evidence exists that at least one of the reactions taking place with chlorine is the substitution of the hydrogen atom to give chloramine-like bodies toxic to bacteria :

$$R — CO — N\,Cl — R.$$

If iodine forms similar compounds, they would be much less toxic than the corresponding chloramins, for the germicidal power of the halogens is inversely proportional to their atomic weights. The other type of combination which may take place is the substitution of iodine for hydrogen in the side chains or amino acid residues of the protein molecule. At least one such example is known, for Plimmer (21) states that 3.5 di-iodotyrosine is formed by the action of iodine on proteins. Harington (22) isolated d.l. 3.5 di-iodotyrosine from thyroid, so that presumably this compound has an important physiological function. Unaffected chicks fed on the iodised milk were found to thrive much better than similar birds not receiving the preparation, a fact which is very suggestive in view of Harington's discovery.

The foregoing considerations prompted us to turn our attention first of all to an examination of the blood, cæca and intestines of treated and control birds. This work is now in progress, the results up to date show that the iodine content of samples from treated birds is greater than those from the controls. In particular, the experimental cæca contained appreciable quantities of iodine whilst only traces were found in the controls. The fact that iodine had found its way into the cæca is noteworthy since injections of a commercial preparation of iodine suspensoid into the gizzards of two fowls did not produce an increase in the normal iodine content of the cæca of the first bird after one day, and in the second bird after four days. We do not intend to advance any theory as to the cause of the above interesting phenomena at this stage of our work.

Experimental.—Two hundred c.c. of skim milk were placed in a flask, and a measured volume (20 c.c.) of a solution of 1 gr. of iodine in 50 c.c. of KI added, and the mixture heated on the water bath until the colour disappeared, and no reaction was given with

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starch-iodide indicator. Into a second flask were placed another 200 c.c. of skim milk, and 20 c.c. of water, and the mixture heated for precisely the same time as in the first case. Both flasks were allowed to cool to 40° C., then 5 c.c. of toluol, 2 grams of trypsin added to each; they were then placed in the incubator and maintained at 37° C. Samples were withdrawn at intervals, and the hydrolysis followed by means of Sorensen formol titration.

The results are given below :—

Time of digestion. hours.	c.c. of N/10 NaOH required.	
	Iodised milk.	Control.
0	9.4	9.6
1	12.4	12.6
2	13.9	13.7
3	14.0	13.9
5	15.2	15.0
7	15.8	15.8
12	15.9	15.8
18	15.9	16.0
24	15.8	16.0

It is a matter of great interest that the hydrolysis of the proteins is unaltered by the combination with iodine.

Summary.

This paper presents data obtained in the treatment and control of Avian Coccidiosis. Experiments utilising iodine in milk are described and results obtained in practical application tabulated. These indicate that the combination of this method together with sanitary measures affords a means of control of the disease. Results showing the inefficiency of chemical disinfection are recorded, and other chemical aspects of this work discussed.

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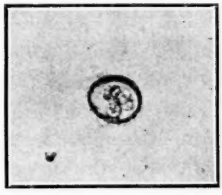

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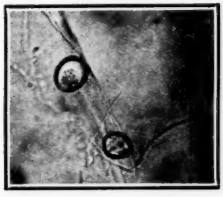

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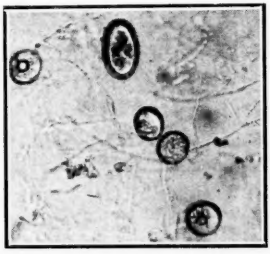

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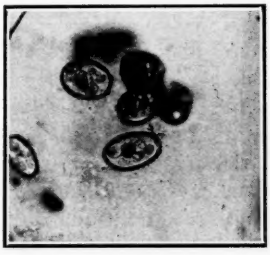

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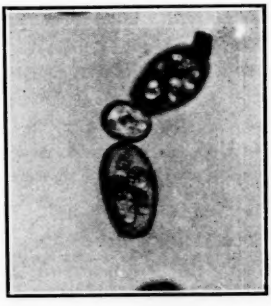

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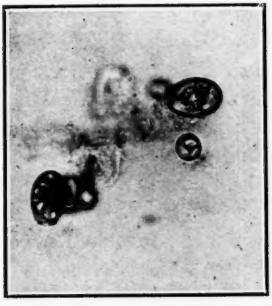

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PLATE I.—*Eimeria avium*. Sporulated oöcyst. Is smaller and rounder than cuniculi. Operculum and residual body small.
PLATE II.—*Eimeria avium*, unfertilised oöcyst.
PLATE III.—*Eimeria avium* showing three sporulated, and two unsporulated oöcysts.
PLATE IV.—*Eimeria cuniculi*, showing sporulated oöcysts. Note size of operculum and large residual body.
PLATE V.—*Eimeria cuniculi*, sporulated oöcyst.
PLATE VI.—*Eimeria cuniculi*, sporulated oöcyst.

THE TRANSMISSION OF PULLORUM DISEASE (BACILLARY WHITE DIARRHŒA) AMONG ADULT STOCK.*

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IT is now universally held that Pullorum Disease (B.W.D.) in young chicks is caused by *S. pullorum*, and that infection is transmitted through the egg, the adult hen harbouring the causal organism in the ovary. *S. pullorum* may also be located in tissues other than the ovary, *e.g.*, in the spleen, gall-bladder wall, kidney, and liver (Doyle, 1925), and we have isolated culture from heart blood. Kerr (1930) has shown recently that the organism may be present in the fæces of adult fowls.

Since Jones (1913) demonstrated the presence of agglutinins for *S. pullorum* in the sera of "carrier" hens, the agglutination test has come to be used as a means of diagnosing the presence of "carrier" fowls in a flock, and is being made use of largely in this and other countries in attempts to eliminate B.W.D. from breeding flocks. At one time it was believed by many that the only natural transmission of B.W.D. was from adult to chick through the egg, and from chick to chick in the incubator and brooder, and that the removal of all birds yielding a positive reaction to the agglutination test from the flock would be productive of a flock entirely free from "carriers" of B.W.D., with the resulting cessation of infection. This, however, has not always proved to be the case, in that it is found a very difficult matter to clean up a flock of birds in which an initial agglutination test has detected many reactors. New reactors are found at subsequent tests carried out at, say, monthly intervals, especially if the non-reacting birds have not been removed to fresh ground. Attention has been directed, therefore, to the possibility of transmission from adult to adult. It was shown by Dalling, Mason, and Gordon (1927) that it was possible to infect normal adult fowls by feeding them

* This research was done in collaboration with the Scientific Poultry Breeders' Association, who kindly supplied the birds.

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cultures of *S. pullorum*. These birds became positive reactors to the agglutination test, and *S. pullorum* was recovered from the ovary. They failed to demonstrate transmission of the disease by sexual contact of infected and non-infected birds. Kerr (1930) has shown that *S. pullorum* can be voided in the excreta, and hence it seems possible that adult stock excreting *S. pullorum* in the fæces may cause an infection in normal unaffected birds on the same ground. Again, eggs laid by infected hens may harbour *S. pullorum*, and the eating of such eggs may prove a further source of infection in healthy stock.

Several workers have carried out experiments to show whether infection from infected fowls (as shown by their being positive reactors to the agglutination test) can be transmitted to healthy stock as evidenced by their passing from the state of non-reactors to reactors. Most of the results recorded up to date indicate that such transmission does not take place, or that it only occurs under certain conditions. Negative results were reported, for example, by Doyle (1925), who penned 50 reactors and 30 non-reactors for 12 months; and by Dalling, Mason, and Gordon (1927), who penned 6 reactors and 6 non-reactors for nine months. Some workers, however, claim to have produced evidence of transmission. Brunet (1928) found that infection did not spread till the male birds were added to the pen. He also records (1930) that in a pen of 14 reactors and 14 non-reactors, infection spread to one bird during the fourth month, while in another pen of 13 reacting and 12 non-reacting hens, with two non-reacting males, no infection occurred during 12 months. Edwards and Hull (1929) penned 15 non-reacting with 73 reacting hens for 12 months, during which time five non-reactors became reactors. Kernkamp (1930) records that of 17 non-reacting hens penned with 17 reacting hens and one non-reacting male for 12 months, eight became reactors.

Because of the conflicting results reported in the literature, and because of the importance of the question, especially to societies, etc., promoting laying trials where hens may be penned together for long periods, we initiated some experiments, preliminary results of which are now recorded.

It was realised that the source of the non-reacting (non-infected) stock was of the utmost importance, hence an endeavour was made to obtain birds of which no doubt could exist as to freedom from infection. Fifty hens were obtained from a flock which had been subjected to the agglutination test bi-annually for the last four years, and in which no reactor had ever been located, nor was there any history of B.W.D. in the flock at any time. Fifty re-actor hens were also obtained. The birds were kept far apart on fresh ground, and agglutination tests were carried out at regular fortnightly intervals.

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The non-reactors remained so, and the reactors all proved reactors. The birds were then divided up as follows :—

(*a*) Six non-reactors were penned with eight reactors in a new house 8′×6′, with a grass run 67′×42′, on which poultry had never been previously kept.

(*b*) Six non-reactors were penned with two reactors in a house 6′×5′, with a grass run 15′×17′ similar to above.

(*c*) The remaining 38 non-reactors were penned together.

(*d*) The 30 remaining reactors remained in their original pen.

All pens were widely separated, every effort was made to ensure their complete isolation, the feeding of all birds was similar, and all the houses were cleansed once a week.

All birds were bled at approximately fortnightly intervals and their sera used for agglutination tests. The titre of serum used in the case of non-reactors was 1 in 10 and 1 in 20, and from 1 in 20 upwards for reactors. The antigen was a 5% saline emulsion of several strains of *S. pullorum* grown on the surface of agar for 48 hours, and killed by heating at 50° C. for 30 minutes. Both incubation in the water bath at 50° C. for four hours, and the rapid shake or slide methods were used in testing all samples of sera. During a period of 18 weeks (*i.e.*, since the beginning of the actual experiment) the sera of the birds in group (*c*) have failed to show any degree of positive reaction. In group (*d*), the reactions have varied considerably, though, on the whole, agglutination at high titres have been found. In group (*a*) the 18 reactors have remained so throughout, with the exception of one bird which failed to react at a titre of 1 in 20, ten weeks after the experiment began, but again reacted at 14 weeks at 1 in 80. The six non-reactors have remained non-reactors. In group (*b*) the two reactors have always shown positive results. The serum of one of the six non-reactors (No. 309) gave a positive result at a titre of 1 in 20 at six weeks, and has reacted at every test since that time. The last test showed the positive reaction at 1 in 160. A second non-reactor (No. 471) showed a positive reaction at eight weeks at a titre of 1 in 40. It also has remained a positive reactor. The four remaining non-reactors are still non-reactors. Hen No. 309 has been killed, and *S. pullorum* has been recovered from the ovary.

Discussion and Conclusions.

Two points of interest arise from the results of this uncompleted experiment : (*a*) Non-reactor hens penned with reactors may, under certain conditions of penning, become reactors. We are satisfied that the conditions of the experiment justify this conclusion,

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for the non-reactors were the progeny of stock known to be non-reactors, and they themselves proved non-reactors on many occasions prior to the beginning of the experiment, while in addition the remainder of the non-reacting stock, *i.e.*, the 38 hens, have remained non-reactors all through the experiment. The ground on which they were penned with the reactors had never been used for poultry, and the house was new. We cannot conceive of any factor which could account for the infection, save the transmission from the reacting hens. It will be of interest at some future date to ascertain whether the two original reactors in the pen are voiding active *S. pullorum*. In view of Kerr's work, this is the probable explanation.

(*b*) Non-reactor hens penned with reactors may become reactors when the space in which they are confined is small. It will be observed that group (*a*) occupied a large grass run, compared with the comparatively small run used for group (*b*), the total space allowed to each fowl in group (*a*) being about 120 sq. ft. as opposed to 30 sq. ft. for those of group (*b*). It seems probable, therefore, that the housing conditions, *e.g.*, intensive system, and the available space per bird, plays an important part in the transmission of B.W.D. among adult stock. In this connection the question of allotment of space at laying and other trials, seems important under the present system of admitting birds.

Summary.

(1) Transmission of pullorum disease (B.W.D.) takes place in adult stock between reactors and non-reactors.

(2) The smaller the space in which fowls are penned the greater is the chance of such transmission taking place.

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SOME SIGNIFICANT POINTS CONCERNING THE PARASITIC WORMS OF FOWLS AND THE CAUSATION OF WORM DISEASES.

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THERE is still a general tendency to regard helminthology as little more than a fuss about the size and shape of worms, with occasional name-changing by way of diversion. The study of parasitic worms is, however, progressing beyond that foundation stage, and it is proposed in this short article to mention briefly other aspects of the subject in connection with some poultry parasites.

The relationship between parasitic worms and their environment is a peculiarly interesting study, and involves the unravelling of a very complex situation ; on the one hand are the adaptations of the parasite towards its host, and on the other hand those of the host towards its parasite. This dual adaptation has progressed throughout the whole of the evolutionary period in which the particular combination of host and parasite has existed. A most evident adaptation on the part of the host is the development of an immunity which the successful parasite has learned to resist, at least in part. A less obvious acquirement, on the part of the parasitic worm, is the ability to live a parasitic life without injuring its host.

Parasitic Worms and Disease.

The perfect parasite (using the term " parasite " in a broad sense) does no harm to its host, for by so doing it tends to destroy its source of existence.

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This increase in verminous disease is traceable to the greater concentration of poultry ; for almost all verminous disease is essentially connected with crowded conditions. A strange complication in the life-cycle of all parasitic worms is their required sojourn in the outside world : they undergo a phase of development either on the ground or in some intermediate host, and are just as much creatures of the outside world as they are of the intestines of the fowl. The soil

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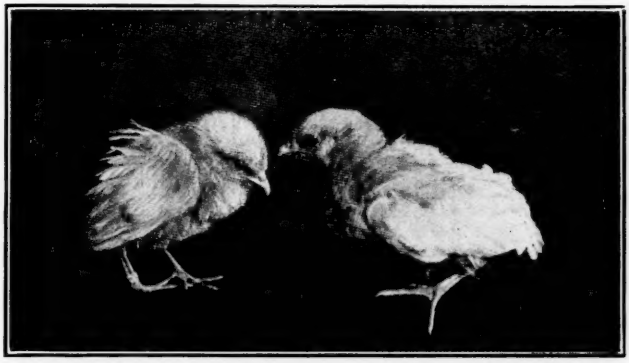

FIG. 49. EFFECT OF LARGE ROUNDWORM (ASCARIS INFLEXA) ON CHICKENS.
Left, parasitized chick; right, control chick.
(Courtesy Ackert and Herrick.)

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POINTS TO NOTE

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Specimen Page

be found on any other part of the body. To find them one must part the feathers in the region of the neck, and the eggs, somewhat different from those of the body louse, are attached to the feathers, close to the roots. There is a tendency to deposit these eggs singly. The lice will be found close to the skin.

Lipeurus infuscatus.—This louse is found only on the head and neck of fowls and is rather common. The louse is moderately long and slender and is seen highly magnified in Fig. 31. The front part of the head is rounded, the thorax is a trifle narrower than the head and the abdomen is long and rather thin.

FIG. 31. LIPEURUS INFUSCATUS.
a, mouth parts; b, abdomen; drawing to right of head indicates actual size.

Fig. 32 shows a seven-weeks'-old Single Comb White Leghorn cockerel badly infested with the head and neck lice. This bird, forty-eight hours before this picture was taken, was the strongest and most vigorous bird of the flock, crowing and master of the household. Note his dejected, partially comatosed condition, bluish colored comb turned over to one side, bluish face and wattles He no longer presents the sleek coat he formerly had. He refuses all food. A nicotine powder thoroughly dusted among the neck

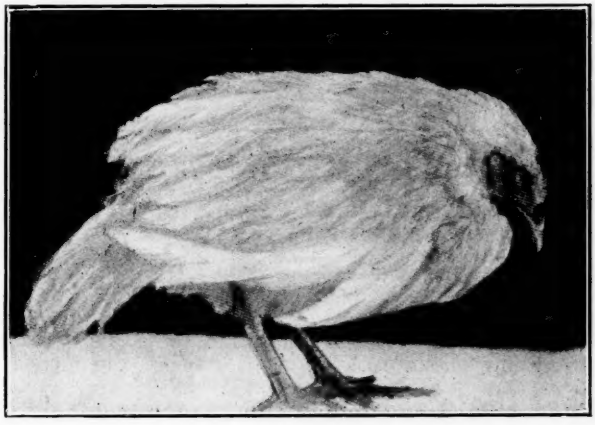

FIG. 32. A PHOTOGRAPH OF A SEVEN-WEEKS'-OLD SINGLE COMB WHITE LEGHORN COCKEREL BADLY INFESTED WITH THE HEAD AND NECK LICE.
Note his dark comb, face, and wattles and the ruffled unkempt feathers. His drowsy condition.

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NOTE.—This page contains one of the many diagrams of the control and cycle of infectious diseases. Instructive and easily memorized.

Digestive disturbances, sudden change of feed or an unnatural large supply of green feed, too much meat scrap or fish scrap, moldy, putrid, or too stimulating feed, drinking water which contains much organic matter and hence is filthy and putrid, foul drinking vessels, drinking from stagnant pools, and exposure to certain unfavorable atmospheric conditions are contributing factors to diarrhea, as is also the ingestion of irritating substances, such as lye, paint, spray-mixtures, unslaked lime, etc. Baby chicks being allowed to become chilled, even for fifteen minutes, may suffer from diarrhea.

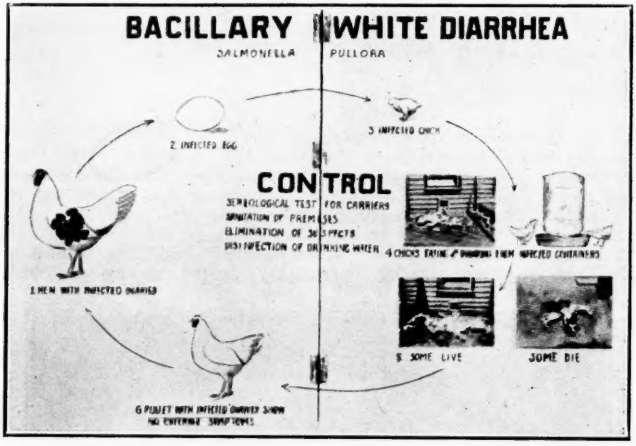

FIG. 80. THE CYCLE OF BACILLARY WHITE DIARRHEA.
The germs are transferred by the infected ovary to the egg, the chick may be developing the disease when hatched. The infected ground and contaminated water are a source of danger. Some of the sick birds die, some live. Those that live may become the chronic carrying pullet.

Along with diarrhea due to the above mentioned causes may be mentioned a like condition sometimes caused by the presence in the intestinal tract of certain species of worms and of irritating foods. Exposure in damp coops, being yarded on damp low ground, cold rains, or draughts often result in digestive derangements of this nature

Symptoms.—The plumage loses its smooth, well kemped appearance; the bird is depressed and not inclined to move about as much as usual; there may be loss of appetite; the crop is full; digestion is slow; the cloaca may be inflamed, appearing

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is therefore a nursery for parasitic worms, wherein they are prepared for their maturer life in the fowl. It is, of course, an elementary point that *worms do not multiply within the body of the host,* but its significance is apt to be overlooked. It signifies an essential difference between the development of a disease caused by worms and of diseases caused by bacteria, protozoa, or filtrable viruses. Whereas mere infection with any of these may lead to such increase of their numbers that disease results, every individual worm must be picked up from the ground by the fowl, and weeks or months of collecting may be necessary before disease appears. This point has been dealt with by the writer at greater length elsewhere, in connection with the worm diseases of sheep, and it has been pointed out that with animals of a given standard infection on an area of ground, two per area pick up four times as many larvæ as does one ; three pick up nine times as many, and ten pick up one hundred times as many, the number increasing as the square of the animal concentration.

It is not necessary to go any further in order to show that poultry parasites must be increasing with the concentration of poultry in this country. In America, where the industry in its present form is older than it is here, parasitic worms are a more urgent problem, and their control a matter of first consideration in the management of a poultry farm.

In spite of their growing importance and the ample evidence of the harm which they can do, we are extraordinarily ignorant on many important points in connection with the relationship between the parasite and the host in health and in disease. It is evidently true of a great majority of parasites that while the presence of a large number causes disease, a few do not ; but we know little or nothing of the number which may be carried with impunity, and the number which produce disease for the various species. The importance of this knowledge becomes very clear when one makes a post-mortem examination and, finding worms to be present, has to decide whether they have been the cause of disease.

Actual knowledge on an experimental basis of damage done by parasitic worms is very scanty, but *Ascaridia lineata,* the large round worm of poultry, is one on which some considerable work has been done. In 1921, Ackert and Herrick began a series of experiments by which they endeavoured to obtain some sound knowledge of the effects of this worm upon its host. Valuable data were obtained which showed it to be capable of doing great harm to chickens up to 10 or 12 weeks of age. In some groups of parasitised chicks a heavy mortality resulted, while survivors showed a greatly retarded develop-

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ment. Older chicks were found to have a well-developed immunity which had nothing to do with any previous infection. The direct effect of this immunity on the development of the young worms in the gut of chickens of different ages is rather interesting: it was found that the larvæ grew to 5.3 mm. in a ten-days period when given to a 5-days-old chick, but only grew to 0.4 mm. in 10 days, when given to a 60-days-old chick, and to only 0.1 mm. when given to 103-days-old chick. The injury to the chickens appears to be done when the worms are young, and bore into the mucous membrane of the intestine, and the mature worms which are found in chickens of more than twelve weeks old are the survivors of an early infection, and are apparently doing no harm.

Heterakis gallinæ, the pin worm of the cæca of fowls, is in several ways interesting from a helminthological point of view. It is of very common occurrence, and is to be found in something like 80% of poultry in this country, appearing to do little or no direct harm. The host-parasite relationship between this species and the fowl are peculiarly interesting. The worm is as perfect a parasite as can be found, in that it does no harm to its host, and some Canadian experimentalists have actually concluded that the cæca of chicks free from this parasite are abnormal in that they are larger, contain more gas, and are thinner walled than is usual. Although this parasite of fowls is of such common occurrence, and the host does not appear to develop an age immunity, heavy infestations are most unusual. Graybill, who did some work on the life-history of this parasite, found that although he could readily produce infection, it was not possible, even by feeding large doses of infective larvæ, to produce a heavy infection. This limitation of infection without a definite immunity appears to be an exceptional condition, although its occurrence cannot be regarded as established until further work has been done.

This worm is also of interest because of its association with "black head" of turkeys. For a long time *Heterakis* has been under suspicion as a transmitter of blackhead, but Tyzzer has shown that it actually plays the part of intermediate host, and has demonstrated that the causal organism may be present, not only in the mature *Heterakis*, but also in the eggs, and it is only through the intervention of this parasite that blackhead can be transmitted. The protozoan parasite, *Histomonas melegaridis*, which causes blackhead, is a common parasite of fowls, where, however, it rarely does harm. Since the causal organism and the helminth vector are both common to fowl and turkey, it is a very good reason for keeping these two kinds of poultry apart

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from one another ; in this instance the turkey contracts a disease from what is usually a harmless parasite in the fowl, and an instance of danger to chicks from a turkey parasite will be mentioned later.

Syngamus trachea.—In contrast with *Heterakis gallinæ*, *Syngamus trachea* is very poorly adapted to the chicken host, where it is one of the most harmful of worm parasites, and at times is responsible for very heavy loss to the poultry farmer. The great majority of parasitic worms are specific in their host requirements, but *Syngamus trachea* is an exception. It has been reported in the black stork, rook, hooded crow, magpie, jay, starling, sparrow, linnet, woodpecker, martin, swift, thrush, peafowl, pheasant, partridge, turkey, and pigeon, as well as in the domestic fowl. A second interesting point about this worm in its relationship to the chicken is the very definite immunity which this host develops after the age of seven or eight weeks. At that age any mature gapeworms which may be present in the trachea of the chick die, and it is not possible to produce further infection. This immunity is not connected in any way with a previous infection with the worm, but is entirely dependent upon the age of the chick. There is a good deal of evidence for the presence of this " age immunity " in connection with a number of helminth parasites, but the instance of *Syngamus trachea* in the chick is one of the most clearly defined, all possibility of its confusion with an acquired immunity being easily ruled out. The turkey develops no such immunity with age, and although young turkeys cannot carry many of these worms without suffering from gapes, mature turkeys can carry a number without any apparent ill-effect. Ransom, who was the first to point out this important aspect of the disease, regarded the turkey as the normal host, and the chicken as an abnormal host for this parasite, arguing that no parasitic worm in its normal host could possibly be so harmful as is *Syngamus trachea* to the chicken. This presents a second obvious reason for not keeping turkeys and chicks together, the turkey in this instance being a danger to the chick.

Another important point about *Syngamus trachea* is its interesting association with the earthworm. At one time it was claimed that the earthworm was a necessary intermediate host, but this was afterwards shown not to be so, and all idea of the earthworm's part in the life-history, except as a mechanical transmitter, was dropped. It has recently been shown, however, that the larvæ of the gapeworm encyst in the muscular tissue of the earthworm. From the parasite's standpoint, this ability to encyst in the earthworm is very advantageous ; if from the large amount of soil which passes through its gut, the earthworm collects and stores all syngamus larvæ, an excellent

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means is provided for gathering together an infective dose, and enticing the chick with a bait to take it.

Davainea proglottina.—This worm is involved in the complex problem concerning the causation of fowl leucæmia and fowl paralysis. It is a small tapeworm, the larval stage of which is found in some species of slugs. Like the pinworm, *D. proglottina*, is of very common occurrence, and in 100 birds taken at random from those coming into this laboratory, it was found to be present in 43. When occurring in small numbers only it appears to cause no injury, but by several observers it has been found associated with fowl paralysis and with fowl leucæmia, and the inference is that this worm acts as a vector of the specific virus, or in some way prepares the fowl for the development of the disease. Opinions on the importance of the worm in these diseases are, however, diverse, some authorities holding that the worm is in no way implicated.

Where disease among animals exists there is a potential field of work for the veterinarian, and there seems to be no reason for the exception of poultry disease. In the United States of America, where the poultry industry in its present form is older than in this country, the veterinary practitioner is doing all he can to learn how to be useful to the poultry farmer. In 1929, a special poultry section was inaugurated at the annual meeting of the American Veterinary Medical Association; at his opening address the Chairman of this Section gave some very surprising figures, taken from the U.S. Depai tment of Agriculture Report for 1923, one or two of which might be mentioned here. The total value of the poultry crop in 1923 was greater than the value of all the cattle, six times the value of all the horses and mules, and seven times the value of the sheep, while it exceeded the value of the wheat crop by three hundred million dollars. Since 1923, the proportionate value of the poultry has increased.

In this country the annual value of eggs and table poultry is approximately equal to the value of the total cereal crop, and the proportionate value of the industry is increasing rapidly, there having been a 12% increase in production in the last twelve months.

On account of the greater concentration of fowls, disease is becoming increasingly prevalent, and advice on diagnosis and lines of treatment when epidemics appear will be more urgently called for. It is true that we know but little about poultry diseases, and very little about their worm diseases, but it might repay the veterinary practitioner to acquire what information is available, and to make an attempt to add the poultry farmer to the list of possible clients.

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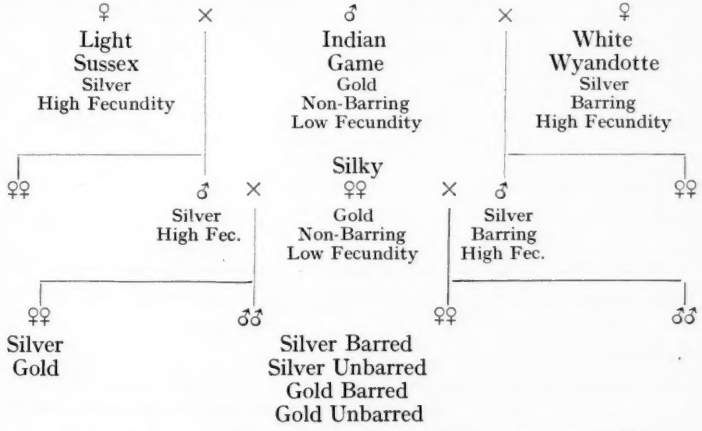
SOME EXPERIMENTS CONCERNING FECUNDITY.*

By R. C. PUNNETT, F.R.S.
Cambridge University.

WHEN the World's Poultry Congress met at Barcelona in 1924, I sketched the outline of some experiments on fecundity which Mr. Pease and I had started in Cambridge, and promised some account of them at a future meeting. These experiments were designed to test whether there existed any sex-linked factor with a definite influence on the fecundity of the hen. On the chromosome theory of heredity, now generally accepted, all sex-linked factors, being in the same chromosome, must show linkage with one another. Hence, if there exists a sex-linked factor for fecundity, as Pearl claimed, it must show linkage with the factors for silver and barred plumage. Our plan, therefore, was to produce cocks which should receive the factors for *silver*, *barring*, and *high fecundity* (supposing for the moment this to be influenced by a sex-linked factor) from their mother, and from their father *gold*, *non-barring*, and *low fecundity*. As explained in the Barcelona report, we started by crossing a Plymouth Rock hen with a Black Sumatra cock, the latter breed being a potential gold of fairly low fecundity. Certain technical difficulties, however, led us eventually to discard this cross, though, as will appear later, it was not altogether without value. In our revised experiments an Indian Game cock was mated to a Light Sussex and to a White Wyandotte hen, each with a good pullet record, *viz.*, 200 for the Light Sussex and 240 for the White Wyandotte. The Indian Game ♂, on the other hand, came from a strain of low fecundity. The White Wyandotte ♀, fortunately,



* A paper presented to the Fourth World's Poultry Congress, 1930.

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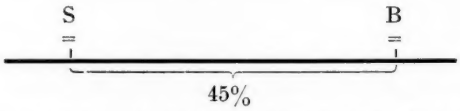
turned out to be carrying barring as well as silver, all of her sons being barred silvers, and her daughters unbarred golds. The F_1 cocks were then mated with Silky hens in order to produce pullets, as shown in the appended diagram.

Since all hens, no matter what they are, must always transmit to to their daughters gold and non-barring together with low fecundity (supposing this to be controlled by a sex-linked factor), it follows that the pullets from such a cross will give the direct measure of the nature of the germ-cells produced by the F_1 cock. From independent experiments we know that the two classes of germ-cells, silver barred and gold unbarred, owing to linkage, form about 55 per cent. of the total produced by such a cock, while the two classes, silver unbarred and gold barred, form about 45 per cent. This means that, in the sex chromosome of the cock, the factors for silver and barred are separated from one another by nearly half of the length of the chromosome, thus :—



Now if there is a sex-linked factor for fecundity (F), it must also lie in this chromosome, and must show linkage with S and B. If it lay close to S the majority of the silver pullets from the cross between the F_1 % and the Silky hens would be distinctly better layers than the rest, whereas the majority of the gold pullets would be well below the average of the whole batch. If, however, F were close to B, the barred pullets as a class would contain a much higher proportion of good layers than would the unbarred ones, and their average would be distinctly higher. Again, if F were midway between S and B, the average of the barred pullets would be higher than that of the un-

TABLE I.

	Number of Birds.	Total Eggs.	Average per Bird.
Silver, barred	16	1,808	113.0
,, unbarred... ...	12	1,354	112.9
Gold, barred	5	791	158.2
,, unbarred	6	772	128.7

barred, and at the same time the average of the silvers would be higher than that of the golds.

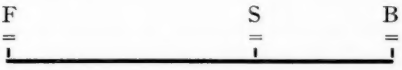
From the White Wyandotte × Indian Game cross, 39 pullets of the four colour classes have given the records summarised in Table I.

Taken together, the barred, with 21 birds, average 123.7, and the unbarred, with 18 birds, average 118.1 ; while the 28 silvers average 113.0, and the 11 golds 142.1. The average for the barred birds is rather higher than that for the unbarred, but of very doubtful significance. In so far as gold and silver are concerned the average for the former is markedly higher—exactly the reverse of what should occur if there were a sex-linked factor for fecundity. The results are somewhat irregular, owing, doubtless, to the small numbers investigated,* but we are fortunate in being able to supplement them by other data.

In the case of the gold-silver pair we raised and tested 26 pullets from the F_1 cock ex Light Sussex × Indian Game ♂ mated with Silky hens (*cf.* diagram, p. 33). The 10 silvers averaged 100.9 and the 16 golds 112.4, a result which clearly negatives the existence of a sex-linked fecundity factor anywhere near that for silver.

In the case of the barred-unbarred pair we raised and tested a number of pullets from an F_1 ♂ (ex Plymouth Rock ♀ × Sumatra ♂) mated with Silky hens. Twenty barred pullets averaged 80 eggs, while 20 unbarred ones averaged 84. Evidently there was no sex-linked fecundity factor anywhere near that for barring.

Taken together, the evidence appears to us to tell definitely against the existence of a sex-linked fecundity factor such as was postulated by Pearl. There is, however, one further possibility. If a sex-link fecundity factor (F) were at one end of the chromosome and the barring factor at the opposite extreme, the configuration of the sex-chromosome would be :—



and in such an arrangement F would not show appreciable linkage with either B or S. In order to decide this point, we must devise crosses with some sex-linked factor that lies between S and the problematical F ; and it is possible that the LI factor of Hertwig may here be of use.

* The high average for the gold barred birds is partly due to the fact that the proportion of earlier hatched birds was higher than in the other groups.

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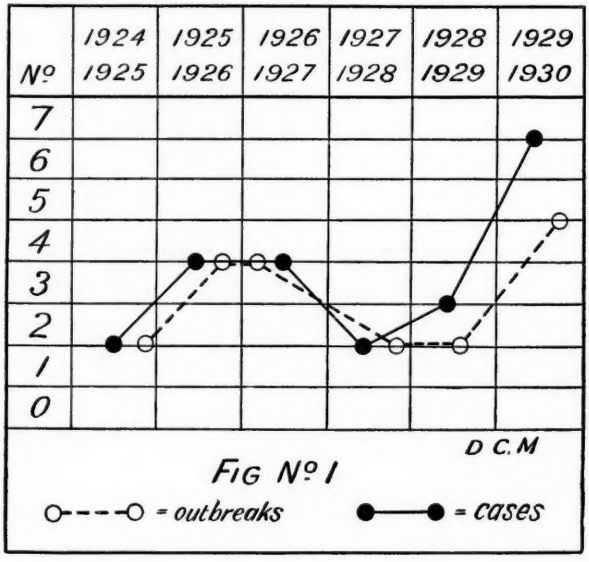
STUDIES IN THE EPIZOOTIOLOGY OF AVIAN TUBERCULOSIS.

By D. C. MATHESON, F.R.C.V.S., D.V.S.M(Vict.).
From the Department of Pathology, Bacteriology and Meat Inspection, The Royal (Dick) Veterinary College, Edinburgh.

DURING the past six years the writer has had under observation for a period of twelve months each, six high-grade flocks consisting of from four hundred to six hundred pullets, drawn from various parts of Great Britain ; housed under first class conditions ; scientifically fed ; and controlled by skilled management. The birds came under observation in October of one year and remained under observation till September of the following year. Each bird was carefully examined (Matheson, 1) before being allowed to enter the flock ; any bird not in apparently good health was rejected. The comparatively small number in the first flock was due to the rigorous eliminating examination, which, however, was justified subsequently by the improved type of bird that was presented for acceptance. The birds were arranged in groups of six, each group having a separate pen and a separate grass run, providing ample accommodation. The breeds represented included : White Leghorn, White Wyandotte, Rhode Island Red, Ancona, Black Leghorn, Light Sussex, Buff Rock, Barnevelder, Black Minorca, Exchequer Leghorn, Barred Rock, Cuckoo Leghorn.



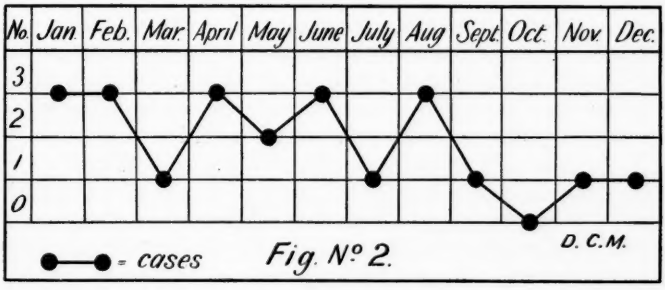
Every bird dying during the period of observation was submitted to post-mortem examination in the writer's laboratory. Tuberculosis was one of the first diseases to make its appearance.

Fig. No. 1 shows the number of outbreaks and the number of cases which occurred in each of the years under observation. It will be noticed that it was not until the last two years that more than one case occurred in one pen. The sharp rise in the number of cases in the period 1929–1930 was due to the fact that in one pen several birds were affected. The actual number of outbreaks was, however, larger by one than in previous years. The following table gives the monthly incidence of cases of the disease for each of the years under observation :—

TABLE NO. 1.

	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930
January	—	1	1	—	—	1
February	—	1	—	—	—	2
March	1	—	—	—	—	—
April	—	—	1	2	—	—
May	—	1	—	—	—	1
June	—	—	1	—	—	2
July	—	1	—	—	—	—
August	—	—	1	—	2	—
September	—	—	—	—	1	—
October	—	—	—	—	—	—
November	1	—	—	—	—	—
December	—	—	—	—	—	1

Monthly incidence of cases for each year.



Monthly incidence of cases over six-year period.

Fig. No. 2 shows the monthly incidence of cases of the disease over the six-year period. Tuberculosis is not a seasonal disease: the finer months of the year show a notable proportion of cases, even June is not exempt; the present writer has shown that June may also be an anxious month for the chicken raiser (Matheson, 2 and 3)

TABLE No. 2.

Year.	Flock No.	No. of Fowls.	Percentage of total deaths contributed by tuberculosis.	Percentage per population.	Per thousand.
1924–1925	1	402	6.6	0.49	4.9
1925–1926	2	516	10.81	0.73	7.3
1926–1927	3	588	9.75	0.68	6.8
1927–1928	4	600	5.12	0.3	3.0
1928–1929	5	600	9.09	0.5	5.0
1929–1930	6	600	14.0	1.16	11.6
1924–1930	All	3,306	9.56	0.66	6.6

In considering the figures in table No. 2, it must be remembered that we are dealing with high-grade flocks; grouping these together as in the bottom row, we find that out of 3,306 pullets coming under observation during a period of six years, tuberculosis contributed 9.56% to the total number of deaths, and it is interesting to compare this figure with that for a number of fowls of all grades examined during a period of thirteen years: Tuberculosis accounted for 11.08% of total deaths (Matheson, 4) The birds which ultimately perished of tuberculosis in the present investigation came from fourteen districts; from the same district and same place, twice; from the same district but not the same place, twice; otherwise the districts were distinct and widely separated in England and Scotland. The disease is widespread, but Great Britain is not alone in this respect; the disease is serious in America (Mohler, 5), and on the Continent of Europe (Beller, 6). With regard to the occurrence of the disease in the pens, it is important to notice that so far the disease has never recurred in the same pen in any of the following years, and we have already pointed out that one case only generally appears in one pen, that is, estimating the number of cases by the number of deaths; the one bird may infect its pen-mates, but death from tuberculosis does not usually come to them during the year

of observation. The exceptions have been noticed above. Circumstances did not permit of the use of the tuberculin test. Even when the disease has appeared in subsequent years in adjacent pens, or pens in proximity, an average interval of more than two years separates the cases. The pens are disinfected, and the soil covered with a dressing of lime after every case. At the present rate of progress the time will come when every pen will have had its case of tuberculosis, but that will be because the birds have brought the disease to the observation ground, not because they have contracted the disease from the pen or ground.

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AVIAN DIPHTHERITIC ENTERITIS AND SWINE FEVER.

By JOHN P. RICE, B.Sc., M.R.C.V.S.

Animal Diseases Division, Ministry of Agriculture, Strandtown, Belfast.

WHILE diphtheritic enteritis in poultry is sometimes caused by the virus of fowl pox, an independent sporadic type of unknown ætiology seems to exist. It occurs in flocks apparently free from fowl pox, and in individual birds which exhibit no skin or mouth lesions of the latter disease.

Generally in these sporadic cases the lesions are confined to the terminal portion of the small intestine and the initial part of the large intestine. The wall of the intestine is considerably thickened, and the internal surface is covered with a rather soft, yellowish false membrane. Distinct " button " formation has also been observed by the writer.

In view of the similarity of the lesions to those seen in swine fever, experiments were undertaken to ascertain if there was any relationship between the two conditions.

Material for the experiments was derived from a case of diphtheritic enteritis received from a laying test, which was reported free from

fowl pox. Portions of the liver and intestines of the bird were macerated in normal saline solution and passed through a Berkefeld filter. The filtrate was found to be sterile after three days' growth on agar at 37° C.

Five c.c. of this filtrate was inoculated subcutaneously into an apparently healthy pig, which had been under observation at the laboratories for some time previously. The animal was kept in a special isolation sty about one hundred yards away from other pigs. It was provided with a separate attendant, and was given only food which had been sterilised by boiling.

The pig died fourteen days later with a temperature of 105° F. Post-mortem examination revealed hæmorrhagic lobar pneumonia, gastro-enteritis and petechiæ in the kidneys.

Blood from this pig was passed through a Berkefeld filter. The filtrate, which gave no growth on agar, was inoculated into a second pig. The same precautions regarding isolation and feeding were observed as previously. On the fifteenth day the animal had a temperature of 107.2° F., and showed diarrhœa. On the nineteenth day the ears were injected, and on the twenty-third day cyanosis appeared. Death took place on the twenty-sixth day.

Post-mortem examination showed the following lesions: cyanosis, necrotic pneumonia of right lung, enlargement of the mesenteric glands, ulceration of the cæcum and colon, and "turkey-egg" kidneys.

The writer and his colleagues had no difficulty in accepting the case as one of typical swine fever.

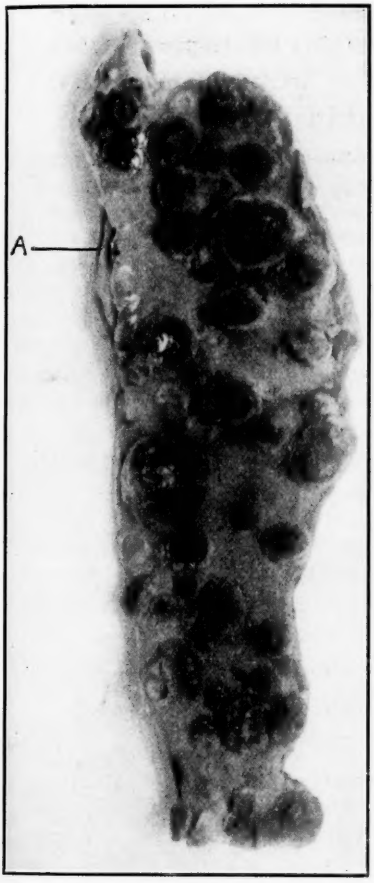
A converse experiment was also carried out. Known swine fever filtered virus was inoculated subcutaneously into six hens. One hen died after nine days, and showed on post-mortem examination acute peritonitis and enteritis with marked serous exudation in the body cavity. The exudate was sterile.

Discussion.

In these experiments the greatest care was taken to avoid accidental infection. The risk of the pigs harbouring a latent virus before inoculation was as far as possible minimised by close preliminary observation of the animals. In the circumstances it is very difficult to avoid the conclusion that the avian virus was successfully passed to pigs in which it produced typical swine fever.

The fact that these two diseases apparently bear no relation to each other under natural conditions should not prevent the acceptance of results indicating an experimental relationship. In certain other virus diseases which are clinically distinct, the barrier of natural

specificity has yielded to artificial inoculation. Thus it has been shown that fowl pox and pustular stomatitis of horses are closely related to each other, and to other animal variolas. In fact it has been claimed that from fowl pox a strain of vaccinia was evolved which produced typical lesions and conferred immunity in calves.



Intestine of hen showing follicular ulceration (natural size). *A. cæcum.*

Intestine of hen showing diphtheritic lesions (natural size).

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Such evolution is capable of explanation on the ground that the viruses of fowl pox and of vaccinia are merely variants of a parent type which have adapted themselves to certain species of animals, the differences in the tissue composition of which determine the differences in the lesions produced. The results of the experiments now recorded would also appear referable to this hypothesis of virus variation.

ON SIGNIFICANT MODIFICATIONS OF FEATHER TYPE INDUCED BY INJECTIONS OF FEMALE SEX HORMONE (OESTRIN) TO CAPONS.

By A. W. GREENWOOD, and J. S. S. BLYTH.

Department of Genetics, University of Edinburgh.

DURING the course of an experiment which yielded negative results in regard to its primary aim—the testing of the influence of oestrin on comb growth in the capon—it was noted that well-marked changes were taking place in the feathers growing in at this time. Since the changes were of a kind differing considerably from those obtained by others employing a similar technique, it seemed desirable to record our data together with a suggested interpretation of the divergent results.

For the investigation two Brown Leghorn capons, hatched in May, 1929, and castrated when five weeks old, were employed. Injections of female hormone (oestrin) were commenced when the birds were 45 weeks old. The oestrin was obtained from Professor E. C. Dodds, of the Middlesex Hospital, to whom our thanks are due, and contained 10 rat units per c.c. Data relative to the series of injections are given in the accompanying table :—

Period of Injection.	Daily Dose.	Number of Daily Injections.	Total Amount Injected.
22/3/30—29/3/30	4.0 c.c.	2	32 c.c. in 8 days
4/4/30—16/4/30	1.5 c.c.	3	19.5 c.c. in 13 days
17/4/30—18/4/30	0.5 c c	1	1 c.c. in 2 days
19/4/30—21/4/30	1.0 c.c.	2	3 c.c. in 3 days
22/4/30—27/4/30	1.5 c.c.	3	9 c.c. in 6 days

The total amount of oestrin administered to each bird was 64.5 c.c. (or 645 rat units) in 32 days.

Plumage Changes.

Since at the outset of the experiment it was not intended to take the plumage into consideration, no plucking of feathers from various regions of the body had been made. It is known, however (Benoit), that in capons there is a kind of continuous moult throughout the year, and that some growing feathers can always be found in all parts of the body. It was in such feathers that the modifications to be described were first noted.

In the cape and shoulder regions new feathers growing in towards the end of the injection period were not of the typical colour and structure; instead of being red and heavily fringed with a small black triangle just above the downy basal part, they exhibited a rounded or blunt apex, and the red fringe had disappeared with the exception of a short lateral area about half way down the vane. The non-fringed part of the feather was solid black, or showed only a few red specks in the apical region. Feathers growing in after the injections had ceased showed the same modifications, but when a slight fringing occurred it was found near the apex of the feather, which again tended to be more pointed. Feathers developing later returned to the normal type.

Saddle feathers showed a tendency to follow the same type of modifications. In feathers which had begun to grow normally with a fine lanceolate point, the blade showed a sudden expansion at the expense of the fringe, and the black pigment extended much further distally than usual. Feathers which had been from the first under the influence of the hormone were seen to be much shorter than normal. The effect of constriction seen in the cape feathers and produced by the appearance of deeper fringing at various levels of the feather vane was present in some saddle feathers, and also in the neck hackle, where comparable changes were exhibited. This is probably attributable to the fact that a lapse of six days occurred between the first and the second series of injections. No change was expressed in the breast feathers, which were black and round-tipped as in the normal.

The feather modifications outlined above do not coincide with the results of other workers (Juhn, *et alia*; Freud, *et alia*), who found that the plumage changes induced in the capon or male took the form of a complete transformation to the female type of feathering, round-tipped unfringed feathers being obtained which were salmon in the breast and pencilled with black on the back and wing.

In a previous paper (Greenwood and Blyth) on the relation of thyroid and gonad to plumage characterisation in the Brown Leghorn,

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certain conclusions were drawn which have a direct bearing on the present data. Hypothyroidism, it was found, resulted in a decrease of melanin, and a coincident increase of red pigment in the feathers, associated with an increase in the amount of fringing due to the lack of barbule formation. Hyperthyroidism produced the opposite effect. In the first case the characteristic female pattern in the feathers tends to disappear, while in the second it shows practically no modification. From this it was concluded that, while the plumage typical of the male is developed independently of the testes, and depends for its colour and structure on a certain level of thyroid functioning, in the female both gonad and thyroid play a part: the former stimulates the latter to a higher level of activity than that characteristic of the male or the capon, and so causes a hyperthyroid effect on the feathers. At the same time it modifies this effect by acting directly on the feathers and restricting the deposition of melanin.

The picture presented by the modified feathers from the birds in the present study is just what would have been expected in a case of simple hyperthyroidism. Since, however, Juhn *et alia* obtained complete female plumage by the injection of female sex hormone, the question arises whether this is to be considered as an intermediate stage in a process leading to complete feminisation of the feathers. The facts that in this experiment the total amount of oestrin injected, and the period over which the injections continued, were respectively less and greater than those employed by the American workers,* can be made to supply a reasonable explanation of the divergency in the results, and to support our previous hypothesis. The explanation advanced is that the amount of oestrin injected was only sufficient to produce one of the ovarian effects postulated above, namely, the stimulation of the thyroid, while the larger doses given by other workers were sufficient to produce both effects and so call forth typical female plumage.

* Juhn, *et alia*, found that typical female feathering was produced in adult capons and mature cocks when 60 rat units were injected daily over a period of three weeks.

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Clinical Articles

Coccidiosis in Chickens.

By G. MAYALL, M.R.C.V.S.
Bolton.

THIS disease probably comes a good second to B.W.D. in the deaths it causes in young chickens. It is commonly found in chicks from one to six weeks old, and may also affect young turkeys, pigeons, pheasants, and peacocks. It is essentially a fæces originating and spreadable disease. Food or water or ground becomes soiled with the sporulated oöcysts, which are taken up by the fledglings and soon cause disaster among them. It may be taken for granted that wild birds spread the disease, and that rabbits, rats and mice harbour and spread the cysts. Flies, too, carry infection by transmitting unsporulated cysts to fowl fæces in which these sporulate and cause further infection to chicks (Fantham and Hosoda). Adult hens may also act as carriers. Mysterious outbreaks where every possible precaution to avoid infection has been taken may be attributed to the agency of flies.

What advice then should we give to the poultry keeper to guard against the losses inflicted by this protozoon?

Where chicks can be reared on wire netting raised from the ground the origin of this disease is largely avoided. The battery brooder, recently introduced into the poultry world, largely obviates the diseases to which young chicks are liable. The hatching and rearing outfits must be kept scrupulously clean and dry, and eggs that may transmit infection through soiled shells should be washed clean with warm water, or rubbed over with 95 per cent. alcohol. The free use of hot water about the chicks' abode is desirable where it can be conveniently done. Food and drinking utensils should be kept clean and placed so that the chicks cannot soil them with their fæces, or scatter the food about on the ground. Rats and mice must be cleared out. As preventives, dried milk or lactose in the food is recommended, and new purchases should be quarantined for a period.

The post-mortem appearances in coccidiosis are usually very plain. The cæca are enlarged and the walls inflamed, and deposits of various colours, consistency and size are found blocking them up. Often the contents are putty-like, and may be knobbly and adherent to the

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gut walls, hard, and either white or brown in colour. We recently had a mass weighing three-quarters of an ounce, and measuring one and three-quarters of an inch long, and three-quarters of an inch in diameter, from a six weeks' old turkey chick. It has not always been our experience to find brick-red or blood-stained deposits, but scrapings from the cæcal wall or smears from the fæces have always revealed coccidia. The best way to make a diagnosis is always through a post-mortem.

What advice can you give to a man who has an outbreak of the disease in his stock? The routine advice is usually 15 grains of catechu dissolved in each gallon of drinking water, or butter-milk as diet. Whatever medicinal agent is recommended, we think it is quite as important to indicate that an impervious floor is a great asset in the treatment of this ailment. If this can be secured and a double apartment planned on it, some progress can be made. The chicks are shifted daily from one abode to the other, and in the interval the vacant quarters are cleansed and disinfected, and the fæces gathered up and burnt. The worst affected chicks should be destroyed. Commercial sulphuric acid is said to be the best disinfecting agent against coccidia, but care must be exercised in its use, and a great deal can be done by means of hot water and soda, and good drainage, and a free use, where possible, of the painters' blow lamp. Recently (VETERINARY JOURNAL, October, 1930, pp. 420–421) Mr. W. R. Kerr, M.R.C.V.S., has written some interesting lines on "The Control and Treatment of Coccidiosis." He hopes for success with an iodine solution in milk, the composition of which is iodine one part, potassium iodide two parts, and water fifty parts. Heelsbergen, in his fine work on "Poultry Diseases," claims most success with lactose, which he gives in the proportion of two parts by weight of powdered lactose mixed with three parts by weight of the morning feed, and kept up each day as long as the disease continues. Any hope of success will, however, always be handicapped unless measures such as we have indicated to secure clean ground are carried out, alongside the therapeutic remedy. The only way of dealing with areas of infected ground is to remove the soil for a depth of six inches, and re-surface it with clean earth, putting the earth removed out of harm's way, or to leave the infected ground vacant of poultry from the beginning to the end of a year.

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Laparotomy in a Pullet.

By H. G. LAMONT, M.Sc., M.R.C.V.S.

Ministry of Agriculture, Stormont, Strandtown, Belfast.

THE subject of the operation was a White Leghorn pullet which had an exceptional egg record in a laying test.

The bird was found for several days in succession in the trap nest, but no egg was visible, though the hen was apparently making efforts to lay.

On examination she was found to have several eggs free in the abdominal cavity. As her egg record was particularly good, the lady superintendent was anxious that the bird, if possible, should be saved.

The feathers were plucked from over the abdominal region over an area in the middle line about three inches long and one and a-half inches broad; any projecting feathers were clipped, and the area cleaned and dressed with tr. iodine. The operation site was injected with about 4 c.c. chlorocain at various points. By palpation a " free " shelled egg was pressed gently against the selected site, and an incision was made through the skin and relatively thin abdominal muscle; the abdominal fat was carefully divided and the egg forced out by pressing from behind. In all three shelled eggs were removed, and two well-formed eggs minus their shells. One of the latter was ruptured in removal, but little, if any, of the yolk contents escaped into the body cavity. Very little difficulty was experienced in keeping the intestine from escaping, a sterilised pledget of cotton-wool, moistened with sterilised normal saline, in the hands of an assistant, being quite sufficient.

The wound was sutured with sterilised cat-gut, the abdominal fat and muscle being sewn together with a series of interrupted sutures. Any fat which showed a tendency to project between the sutures was snipped off with scissors. The skin was sutured similarly, and the wound dressed with tr. iodine, and covered with antiseptic gauze held in position by short straps of sticking plaster. Recovery was uneventful, and the hen recommenced laying within 14 days. The hen did not struggle during the operation, and very little hæmorrhage was experienced, this being attributed to the good effects of the chlorocain.

The writer has since carried out a similar operation with success, and with the same good results. Two other local veterinary surgeons have also performed this operation with very satisfactory results.

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A certain amount of care is apparently necessary in the use of chlorocain as a local anæsthetic in fowl. On one occasion a cockerel with a large anal tumour was injected with 6.5 c.c. The bird collapsed and died in a few minutes. A healthy cockerel inoculated with a similar quantity showed very distressed breathing and darkening of the comb, but recovered in about two hours.

Traumatic Peritonitis in the Fowl Resultant upon Ingestion of Box Nails.

By W. J. LEYSHON.

Veterinary Officer, London County Council.

This condition was encountered whilst the writer was privileged to assist at The Institute of Animal Pathology, Cambridge.

One live with three carcasses of Rhode Island half-grown chickens were brought in by owner with the history that death in five other such birds resulted after they had moped for only one day.

In each of three of the subjects post-mortemed, a box nail, one and a-half inch in length, was found to have perforated the entire wall of the gizzard from the lumen of organ outwards with resultant escape of ingesta into the abdominal cavity. The fourth case was not opened, since the point of a foreign body could be felt subcutaneously, and almost penetrating the skin covering left side of abdomen. It was afterwards learnt that the birds had recently been removed to newly-constructed houses, and it appeared probable therefore that some nails unused in erection work thereof were inadvertently dropped about in litter.

Bird No. 1, destroyed at laboratory, showed a greenish-brown diphtheritic deposit on left side of peritoneal cavity with nail point visible just through puncture in gizzard.

Bird No. 2. Nail point well through gizzard wall ; serosanguineous exudate into subcutis, which was emphysematous.

Bird No. 3. Peritoneal cavity contained considerable quantity of evil-smelling brownish debris ; liver (right side) much discoloured ; nail had penetrated slightly to the right lower side of gizzard.

The crop of bird No. 3 was almost filled with ingesta, but in the others this organ contained less food.

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Reviews

Poultry Diseases. By B. F. Kaupp, B.S., M.S., D.V.M. 5th edition, revised and enlarged. London: Messrs. Baillière, Tindall and Cox. Pp. 436. Illustrations 166. Price 16*s*. net.

In our issue of October, 1930, we published a short notice of this book. We are now able to give it a more extended review.

This volume comprises 436 pages, written in a manner likely to hold the interest of the reader, be he professional or lay, from cover to cover. Text-books devoted to Diseases of Poultry are rare and their want has been long felt by veterinarians, students and poultry keepers. Kaupp's book has been for years one of the standard text-books on the subject, and the present edition places it even higher in the ranks of books of reference. The book has been considerably enlarged and its subject matter brought up to date, for not only are diseases fully dealt with (and it is evident from a detailed examination that the author has spared no effort to acquire the latest available information in their connection), but full chapters are devoted to anatomy, physiology and sanitation.

Anatomy is dealt with in a manner just sufficiently fully to be of considerable value for quick reference work, and is apparently an abridged version of the author's "Anatomy of the Domestic Fowl" (another acknowledged text-book). It may be that, for ordinary purposes, the sections devoted to the nervous system, the eye, etc., enter into detail at the expense of more important anatomical systems.

The chapter on physiology is well done, and in the small space available a good general idea is given of the essentials of physiology; and, rightly, the reproductive system receives much attention.

Sanitation covers many subjects. The chapter will be found of great value to the practical poultry keeper and to the veterinary surgeon, whose advice may be asked at any time on the various conditions essential to the successful raising of poultry. A little disappointment is felt in the section dealing with post-mortem examinations in that to the lay reader it might appear that the diagnosing of a disease in a dead fowl is a fairly simple matter, and so he may be mislead. The chapter also contains references to such subjects as immunity and infection, dealt with as general principles, and while they are treated intelligently, it is felt that such massive subjects, on which so many excellent volumes have been written, might have been more simply dealt with by referring the reader to one or other of the standard works. The lay reader, for whom they were probably intended, may find it difficult to grasp the significance of anti-aggressins, bacteriophage, etc.

Two full chapters are devoted to parasites—external and internal. These chapters, especially that dealing with external parasites, are excellent, and though we may not meet with all the varieties in this country, we are given a comprehensive survey with good descriptions of the life-history and method of eradication of practically all types infesting poultry and other domesticated birds. We would have liked to have

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read more details in connection with the damage caused by intestinal round worms generally, for it is to those with Kaupp's experience that we look for guidance on debatable questions.

The chapter on protozoan diseases treats mainly with coccidiosis and blackhead. The life-history of the former is written in a manner so that all can readily appreciate the various stages. In all probability the volume went to press too early for the inclusion of the latest method of prevention and treatment of coccidiosis by iodine in milk—described by Kerr. The general preventive measures described, however, are of much value. In his reference to Blackhead (Entero-hepatitis), the author notes that in addition to turkey poults being infected, he has met with one outbreak in fowl chicks. We feel that British poultry workers could give experiences of more general infection of the latter.

Chapter 7 deals with diseases of the digestive tract of fowls, and though the author begins by saying that the list of digestive ailments are not so numerous as in higher animals, he succeeds in describing twenty-six, and all are important, and are more or less fully dealt with. We would like to have read more of his views on " pica," concerning especially feather picking and its sequel—cannibalism. The section on muco-enteritis, with which is associated the presence of a filtrable virus, is of the greatest interest and value to those dealing with poultry diseases in this country.

A chapter is devoted to diseases due to bacteria, and includes conditions such as fowl cholera, fowl typhoid, leukæmia, pullorum diseases, " Keel " in ducklings, septicæmias of other birds, spirochætosis, tuberculosis, aspergillosis, etc. Naturally, fowl typhoid, pullorum disease and tuberculosis are among those most fully discussed. The value of fowl typhoid vaccine as a successful prophylactic is supported by figures in connection with 56 outbreaks treated. A note on the making of the vaccine claims that where vaccine has been apparently unsuccessful, " the lack of success is undoubtedly due to the lack of antigenic properties on the part of the organism used in making the vaccine. . . ."

The author has evidently had to deal with workers whose methods suggest carelessness in the laboratory, when he notes that " care is necessary in observing the purity of cultures and to ensure that they have not become contaminated during the process of transferring and incubation." Pullorum disease is discussed in fourteen pages and is very ably dealt with. Full notes are given on the agglutination test and its reliability in ridding flocks of reactors and so reducing the incidence of the disease. The various discrepancies to which most workers are accustomed are discussed, *e.g.*, the erratic reacting of certain birds, variations in degrees of reaction at different seasons of the year, etc. A full description of the technique involved in carrying out the test is given, and it is noted that the author recommends the method of incubating the serum-antigen mixtures for 48 hours in an incubator at 37° C. Reference is also made to the use of " pullorin," but the author does not acquaint us with his views or experiences of its usefulness. Diseases of ducklings, *e.g.*, " Keel," are of considerable interest to us in this country ; a fuller description, especially of the causal organisms, would have been appreciated. Under tuberculosis, which is well discussed, is a heading—" Tuberculin Test "—and it is claimed that " intra-dermal tests of tuberculin made from the avian type of tubercle bacillus has

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proved satisfactory," and that " Tuberculin prepared from the bovine variety has been used with good results." Further details of the making of the tuberculin and of the experiments from which the conclusions were drawn would have added value to the section, as it does not appear that all, in this country at least, will be in full agreement with the author's statements.

Chapter 9 deals with constitutional diseases, *e.g.*, gout, nutritional diseases, etc., which, as the author says, " to the present time are not understood." Descriptions of conditions due to deficiency of the various vitamins A – E, close the chapter.

A chapter on diseases of the respiratory passages consists of descriptions of conditions, such as obstruction of the trachea, catarrh " colds," asthma, bronchitis, pneumonia, etc., as well as chicken-pox in its various forms. It is of the utmost value to have Kaupp's opinion that the various diseases of the head of fowls, *viz.*, chicken-pox, contagious epithelioma, diphtheritic roup (Canker), roup, diphtheritic sore-eye, are manifestations of the action of the same filtrable virus. In his excellent description of vaccination against fowl-pox it is unfortunate that he did not refer to the good results accruing from the use of live pigeon-pox virus, elaborated in this country by Doyle.

Diseases of the liver and of the ovary and oviduct each receive a chapter. The explanation of the occurrence of abnormal eggs, *e.g.*, those containing more than one yolk, blood spots, thin shells, etc., are highly educative.

In Chapter 13, under the heading General Diseases, come conditions so varied as purulent oviductitis (whites of hens), ascites, diseases of the heart and blood vessels, dermatitis, broken beaks, etc. Each subject is of interest.

A chapter of 23 pages deals with tumours. Tumours are classified in much the usual way and are described individually, reference being made to examples found by the author and others. The chapter will be of value to those specially interested in this branch of poultry pathology.

Chapter 15 is devoted to a description of diseases of the nervous system. The author recognises many of the diseases as found in other animals, *e.g.*, myelitis, epilepsy, apoplexy, polyneuritis, etc.

Short chapters deal with (1) bacteria of the intestinal tract of the fowl (a very useful reference) ; (2) animal parasites and bacteria of eggs (in which we learn that of the yolks of fresh eggs, 9.5% contain bacteria, and of the whites, 1.2%) ; (3) malformations (with many excellent drawings and diagrams) ; (4) fractures, wounds, etc. (in which descriptions are given of the process of repair of bone, the method of anæsthetising fowls, treatment for wounds, fractures, etc.) ; and (5) caponising birds (fully described and illustrated).

Chapter 21 will be read extensively, as it treats with foods poisonous to fowls, including salt and arsenical poisonings, as well as a full description of botulism (limberneck).

The last chapter is headed poultry remedies, and contains much information, *e.g.*, normal temperature, blood pressure, etc., and a full poultry materia medica. A disease chart, a list of dosage of drugs, a glossary of terms, and an index complete the volume.

It would be grossly unfair to omit to mention the excellence of the drawings, diagrams and descriptive charts throughout the volume. They

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enhance its value in no small measure, being in many cases actual photographs of the condition under consideration ; all are excellently produced. The paper, type and general plan of the book are also to be commended.

We have no hesitation in recommending this volume as a text-book of high order, and we believe, with the author, that Kaupp's " Poultry Diseases," which " has filled a long-felt want and is used as a text-book and reference book in colleges and by veterinarians, student and poultryman alike the world over," will continue to do so.

Correspondence

The Editor of THE VETERINARY JOURNAL.

SIR,—I noticed in a recent issue of the VETERINARY JOURNAL an extract of an article by a foreign practitioner on the benefits of an injection of Tincture of Iodine for relieving cases of lameness due to exostoses in horses.

I may state that this method was used by me as far back as 1925, but I discarded the Tincture of Iodine (which I found unnecessarily irritating) for a solution of Iodine in Paraff. Liq., eventually discarding this for a solution in a vegetable oil, as I found the mineral oil took rather a long time to be absorbed.

Yours truly,

WILLIAM S. STEVENS.

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Obituary

SINCE our last issue the hand of death has been very heavily laid upon the Veterinary profession, as our obituary notice contains the names of no less than five graduates, two of whom were scarcely past their first youth.

Mr. J. Ewing Johnston, M.R.C.V.S., D.V.S.M. (the only son of Mr. Ewing Johnston, the Honorary Veterinary Surgeon to the Viceroy of Northern Ireland), an old Sedbergh boy and a recent graduate of the Dick College (where he recently took not only his Diploma of Membership, but also his Diploma of Veterinary State Medicine), met with fatal injuries in the hunting field, dying in a Belfast hospital a few hours later.

Capt. Lewis Sewell, M.R.C.V.S., the only son of Mr. Alfred Sewell, the well-known Canine Specialist (both father and son holding the Royal Warrant as Canine Surgeons to His Majesty the King), whose death from heart disease at the age of 42 will leave a vacant place, which will be hard to fill, in canine circles.

Major Porteus, of Southsea, and Capt. Stanley Wood, of Eastbourne, each under tragic circumstances ; and Mr. Alexander Bailey, the latter of whom graduated from the London College in the early nineties.

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